Globalisation, Comparative Advantage and the Changing Dynamics of Trade

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Foreword

The aftershocks of the 2008-2009 financial and economic crisis continue to shake the world economy. While GDP, trade and investment have grown in each period since the second quarter of 2009, growth rates have not returned to their pre-crisis levels. Perhaps the most enduring impact of the crisis is the erosion of confidence in financial markets and economic governance. Concerns persist regarding the long-term effects of the extraordinary measures taken in response to the crisis, public debt sustainability, and financial and property markets volatility. Unemployment across the OECD area remains above 8% and youth unemployment is expected to reach 18% at the end of the 2011.

While the world economy remains weak, further policy options are limited: monetary policy in most OECD countries has remained as expansionary as possible since the advent of the crisis and fiscal policy is constrained by public sector debt levels. But structural reforms, particularly those that can generate immediate employment gains without significant government outlays, continue to hold promise. Trade policy, due to its potentially powerful combination of supply and demand side impacts that go to the very roots of economic activity, is one such structural policy. While neither trade nor trade policy caused the crisis, they will need to be a part of the solution.

With rising globalisation, the dividing line between national and international policy interventions is increasingly blurred. Some of the stimulus measures taken to rescue sectors of systemic importance (such as banking), to preserve jobs (as in the automotive industry), or to stimulate growth (such as sector-specific consumption tax reductions), could become elements of "murky" protectionism and discriminate between domestic and foreign goods or firms. Many governments remain actively involved in selected industries that were particularly hard hit during the crisis. While extraordinary measures are warranted during a crisis, they will over time distort markets, generate anti-competitive impacts, invite retaliation, and, perversely, hurt productivity and growth. Such measures are a high price to pay for supporting some economic sectors at the expense of others. Adopting policies to facilitate structural adjustment during a crisis is one thing; using them to artificially boost the price competitiveness of domestic products is quite another.

Embracing structural adjustment is necessary to ensure economies remain competitive and generate employment opportunities into the future. Comparative advantage remains the underlying principle that policy makers can place their faith in to guide economies through this adjustment. The concept of comparative advantage posits that all economies have trade opportunities to exploit and these opportunities stem from differences in factor endowments between countries. As shown by the work in this volume, this continues to be one of the most potent explanations of higher income growth in open economies.

Many developing countries have grown faster and become richer by allowing structural change in response to the forces of comparative advantage. These countries will continue to move up the value-added chain and expand jobs in their traded sectors. Over the past decade, many developed countries experienced output growth, albeit at lower levels, in both the traded and non-traded sectors. Employment growth has predominately come from the non-traded sector, particularly services. But lower transportation costs, new information technologies, and declining obstacles to foreign direct investment and trade are transforming some non-tradeables into tradeables. Continuing to open markets for both goods and services makes sound economic sense, whatever a country's stage of development.

But welfare-enhancing structural change requires that inefficient sectors contract in order to allow for growth in more efficient areas. This reallocation can sometimes be slow, difficult and potentially incomplete. Governments have an important role to play in facilitating and expediting this process, as well as protecting the most vulnerable. Properly designed economic, labour market, education and social policies can serve to enhance the opportunities available to those who stand to gain from trade opening to actually do so and to help those who are displaced to develop new skills and find new opportunities.

Overall, the evidence provided in the book underscores what has been long known, but not always relied upon in policy making. As David Ricardo argued two centuries ago, it is the differences between countries, including differences in broad policy settings and policy performance, that create relative differences in productivity and give rise to trade and gains from trade. But product or sector-specific policies can undermine the gains from trade. More than anything, this implies that trade openness and comparative advantage-driven specialisation is not a constraint to economic development, but rather its catalyst. Market opening and removal of remaining trade distortions, be it via multilateral, regional, bilateral or unilateral approaches, should be among the key structural policy initiatives considered for a balanced and sustained recovery.

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Breaking through on trade: How a changing world dynamic affects policy

by

Przemyslaw Kowalski and Susan F. Stone[1]

Integration of industrialised and emerging economies has shaped globalisation

Integration of industrialised and emerging market economies through international trade and investment has been one of the major factors shaping the global economy in recent decades. Technological advances leading to reductions in trade and communication costs and pro-market reforms reducing policy-induced costs in both industrialised and emerging economies have narrowed the divide created by natural and man-made barriers. They have also enabled more efficient specialisation and greater unbundling of the production process across national borders (OECD, 2006; OECD, 2009).

This integration has generated large economic gains as well as structural change best illustrated by the increasing shares of several emerging economies in world output and rising per capita incomes. The extent of gains and structural adjustment reflect the large differences in initial conditions and resources, which is exemplified by the large pools of labour emerging economies have contributed to the world labour force. Today, when we are still at an early stage of the globalisation era, the BRIICS (Brazil, Russia, India, Indonesia, China and South Africa) continue to account for about 49% of the global labour supply and only 17% of the value of world production. Integration of these economies with the world economy has been, and continues to be, a significant shock to world relative resource endowments and thus the pattern of relative productivity, with ratios of available labour to capital or natural resources increasing at dramatic rates.

Trade and Foreign Direct Investment (FDI) have been among the principal channels through which some of these and other differences in countries' endowments are being reduced. Indeed, evidence presented in this book points out that while many emerging economies continue to export products that have relatively high labour and natural resources content, they have gradually expanded exports of technology, physical and human capital-intensive goods as well (e.g. Chapters 3 and 5). These trends are likely to continue so that further large and pervasive structural changes can be anticipated for the global economy as income levels continue to increase across emerging economies and per capita production and consumption levels approach those of today's OECD economies.

The recent financial and economic crisis was a brusque reminder of the importance of international trade and investment in today's world economy (OECD, 2010). Yet, the crisis also reminded us of the complexity and interconnectedness associated with the unprecedented levels of integration and this has reinforced for some, doubts regarding the direction and even desirability of interdependent global markets. Moreover, the crisis and the uneven pace of recovery that has followed, echo the profound changes in the geography of world trade that has occurred over past decades with the economic weight shifting rapidly away from the OECD economies to emerging economies, most notably in South and East Asia. The massive government intervention in response to the crisis in national, but very much internationally connected, economies triggered concerns about the potential transmission of this intervention's effects beyond national borders (e.g. OECD, 2010).

The relationship between international trade and economic growth and the role of governments in influencing this relationship have been long debated issues in economics and economic policy making. Dating back to the export-promoting and import-restricting mercantilist doctrines of the 17th and 18th centuries and their subsequent critique by the 18th and 19th century precursors of modern economics, the debate in the public sphere is far from concluded today, as evident in the on-going deliberations of the merits of export-led growth, industrial policy, pursuit of specialisation in high value added products, defiance of comparative advantage, or restrictions on trade of raw materials.

This book collects a number of papers reflecting some of the recent thinking about the classical concept of comparative advantage that has been pivotal to studying changes in world trade and assessing their economic effects. It provides an empirical stocktaking of developments in trade in both goods and services and underlying policy factors in OECD and major non-OECD countries in the last two decades and offers reflections on implications for modern policy making. Each of the chapters addresses one or more of the following key questions: *Is comparative advantage still relevant today? How have the patterns of trade evolved? Can governments influence trade patterns in a fashion that is sustainable and beneficial for the country and world commerce?*

The concept of comparative advantage has been pivotal to studying this change

Introduced by David Ricardo in 1815, the comparative advantage hypothesis posits crucially that it is not the absolute differences in countries' abilities to produce certain goods and services that determine what countries produce and trade but rather the relative differences. Thus, as pointed out by Deardorff in Chapter 1, a country that is more efficient in producing a good than any another country (i.e. has absolute advantage in this product) may still find it profitable to import that good and export other goods in which it is relatively more productive (i.e. has comparative advantage). According to the comparative advantage theory countries can enhance their individual and joint welfare by specialising according to this principle through a more efficient use of resources within an economy and throughout the world. In fact, as Deardorff argues, in order to gain from trade, countries' trade must conform to comparative advantage, so that comparative advantage becomes a necessary but not a sufficient condition to realise these gains (Chapter 1).

The Ricardian model of comparative advantage and its subsequent extensions provided a framework to show that (i) open economies gain from 'pure exchange' even if the opening to trade does not change the production structure of the country and that (ii) they can gain even more by concentrating their resources in sectors and products in which they are relatively more productive. The theory also provided a way of measuring these gains and thus of substantiating the long-held observation that countries gain from trade. The concept of comparative advantage has since been identified as one of the most potent explanations of higher incomes and income growth rates of open economies. This understanding has had a strong influence on economic policy making, most notably the trade liberalisation initiatives under the auspices of the GATT and the WTO, which placed emphasis on removing remaining trade barriers and promoting trade-related structural adjustment, so that countries can benefit from comparative advantage-driven trade.

The concept of comparative advantage has also inspired well-known – if not terribly effective – policies such as import substitution and infant industry protection that emerged in the 1950s and 1960s. During this period many governments embraced strong protectionist measures directed against comparative advantage-driven specialisation in primary commodities or unskilled-labour intensive products. This approach advocated import protection in areas where imports competed with domestic production, most notably manufacturing, as new industries in poor countries were deemed ill-prepared for competition with their counterparts in industrialised countries (Krueger, 1997).

The infant industry argument has always had a strong influence on the analysis of policy implications of the comparative advantage hypothesis. First introduced in the writings of John Stuart Mill, it posits that because of dynamic considerations, externalities or large fixed costs, an economically viable industry would not be established by private agents in the absence of some form of help or subsidy from government. However, in practice these policies seldom led to welfare gains for a country (Rodriguez-Clare, 2007). Yet, the generality of the case for targeted industrial policy remains extremely controversial.

The Washington Consensus of the early 1980s led to the implementation of structural adjustment programmes which promoted the power of markets over states in resource allocation and the dismantling of policy regimes which were designed to promote industrial policy (Barnes *et al.*, 2003). Some research inquiries that revisited this concept in light of the unprecedented performance of some Asian economies using targeted policies concluded that these industrial policies had been a failure and that the only viable role Asian governments had played was to promote economy-wide initiatives to correct market failures (World Bank, 1993). However, these negative conclusions have also been questioned, raising fresh doubts as to the extent markets can be relied upon in the development process (e.g. Lall, 1994; Rodrik, 1994; Stilglitz, 1996).

In a recent stock-taking of the industrial policy debate, Rodrik (2009) argued that governments may well be able to help an industry become viable in certain specific circumstances, but he also acknowledged that there are also non-negligible risks associated with such a strategy. Namely, governments may be incapable of correctly identifying the "winners" and, secondly, industrial policy may trigger unwanted rent-seeking behaviour. This may be the case in particular for developing countries which would like to emulate the benefits obtained from industrial policy by some Asian economies (Korea or China are the most frequently used examples) but which do not have as capable bureaucracies and/or the political ability to withdraw stimulating measures at the right time (Pack, 2000). The latter hypothesis has been bolstered by a recent review of the empirical literature which shows that policies instituted based on infant-industry arguments rarely elicited welfare gains (Harrison and Rodriguez-Clare, 2009). Thus, currently, the debate on industrial policy remains "hung up on the question should we or should we not?" (Rodrik, 2009).

Is comparative advantage still relevant today? What do the patterns of trade tell us?

It is within the framework of comparative advantage that questions of policy have traditionally been addressed. But in today's complex trade environment is comparative advantage still a relevant framework for explaining trade flows and a pertinent basis on which to generate effective trade policy strategies? It has been argued that comparative advantage, with its focus on domestically-based resources, is no longer appropriate in a world of integrated markets and fast-changing information technology. Indeed, the increasing mobility across borders of various factors of production, ideas, technology, goods and services, contrast with the traditionally static approach offered by the comparative advantage-based trade models.

In Chapter 2, Kowalski and Cavazos Cepeda outline broad trends in trade, production and consumption and underscore that economic activity is today more international than at any time in the past. Sourcing of foreign intermediate goods has intensified with capital goods (including parts and accessories) the fastest growing category of world trade and processed industrial supplies currently the largest traded category. Motivation for this type of exchange is illustrated in Chapter 7, where Stone and Shepherd provide evidence that firm level productivity is positively affected by these imports of intermediate products and capital goods.

Simultaneously, the distribution of world income and production has been undergoing major changes with a number of lower middle income countries (LMC) and, more recently, upper middle income countries (UMC), growing substantially faster than the high income OECD members. Chapter 2 shows that these changes coincided with the expansion of trade shares of emerging market economies and the decline of manufacturing and agriculture in the OECD area where these sectors account for progressively smaller shares of output, value added and employment. At the same time, these two sectors have become more integrated across international markets, with larger shares of consumption satisfied from foreign sources. Services turn out to be far less traded but the increasing presence of emerging market economies in the global services sector is also visible in the data.

In Chapter 3, Kowalski and Bottini shed light on the question of the extent to which comparative advantage may have driven the observed changes in world trade patterns in manufacturing and agriculture. They address issues associated with measurement of comparative advantage, in particular with reference to one commonly used group of indices, i.e. the Revealed Comparative Advantage (RCA) indices (see also Chapter 1). They analyse cross-sector and cross-country patterns and evolution of RCA indices for a group of OECD and Selected Emerging Markets (SEM) countries[2] at a detailed level of product classification, in the period 1990-2007. In order to link export specialisation developments to some of the posited sources of comparative advantage, they classify products according to their factor intensity distinguishing between: primary, natural resource-intensive, unskilled labour-intensive, technology-intensive and human-capital intensive products.

OECD countries show a tendency for convergence, i.e. for dispersion of RCA indices to diminish in time. However, this is not the case for the SEM economies. This could reflect a negative relationship between the level of economic development and polarisation of export specialisation patterns. Countries at lower levels of development tend to export many products at all ends of the revealed comparative advantage spectrum while richer economies tend to concentrate in products with a clear revealed comparative advantage and export more products with moderate revealed comparative advantage. This finding supports earlier conclusions of the literature linking the level of economic development and concentration of employment or diversification of exports (Imbs and Wacziarg 2003 and Carrere *et al*., 2007).

Various indices of mobility of export specialisation, which capture the probability of products either gaining or losing comparative advantage over time, indicate generally lower mobility of specialisation in OECD economies as compared to SEM economies. Unskilled labour-intensive products present an interesting case with a high degree of mobility of RCA distributions in both the OECD and SEM groupings, but in starkly opposing directions. In the last two decades many richer OECD countries have been progressively losing revealed comparative advantage in unskilled-labour intensive products while SEM countries such as China or India have been expanding their advantage in this kind of products. The lack of such starkly opposing trends in the case of technology and human-capital intensive products, where both the OECD and some more advanced SEM economies are developing comparative advantage, is consistent with the view that integration of SEM economies with the world economy was indeed a particularly significant shock to labour-intensive industries. This also suggests, though certainly does not prove, that mobility of factors could have been of key importance; unskilled labour belongs to the least mobile factors both within and across countries, while technology and human capital can move more easily across countries (e.g. through FDI).

Overall the findings of Kowalski and Bottini would lend support to the view expressed recently by Bhagwati (2007) that, contrary to the claim by Friedman (2005), the "earth is not flat" and that the notion of comparative advantage remains relevant for policy making, especially when it is acknowledged that comparative advantage is not a static phenomenon. Yet, at the same time, the chapter's findings pertaining to specialisation trends in unskilled-labour intensive products call for some caution with respect to what Bhagwati (2007) calls the 'human face of globalisation' since some of these trends suggest that unskilled labour in OECD economies may have borne a disproportionate share of the structural adjustment (e.g. in terms of job losses or wage reductions) associated with re-integration of SEM economies with the world economy.

In Chapter 4, Liapis also considers RCA indices but with a focus on processed products, which represent the largest share of agricultural trade. The chapter shows that trade in processed products is highly concentrated, with the OECD area, along with a few exporting countries, including Brazil, China, India, Indonesia and South Africa, capturing a dominant share of the market. For example, in 2007 exports of processed products from 123 countries contributed less than 1% to the world total of those products while the 20 leading exporters contributed almost 81% (if intra EU trade is included). Those exporting countries capturing the bulk of market share have a revealed comparative advantage in processed products.

Even though most countries export a sizeable number of products in which they have no revealed comparative advantage, those products in which they do are responsible for the majority of their export earnings. Moreover, countries with comparative advantage not only export greater volumes, they also export a greater variety of products offering their customers greater choice while also servicing more partners. While the chapter did not find strong evidence of a relationship between RCA measures in processed agriculture products and proxies for factor endowments, it did find evidence that corruption and cleanliness did matter, suggesting the importance of transparency in food product trade. Finally, examining the relationship between comparative advantage and growth, Liapis found that a 10% increase in the productivity of processed product exports increased income by 0.04%. The chapter thus argues that promoting productivity gains and an export profile resembling the basket of goods of wealthier economies is a viable development strategy. This reasoning is discussed in greater detail in Chapter 11 of this volume.

In Chapter 5, Stone *et al*. take a closer look at the factor endowments in OECD and SEM economies and then examine if the factor intensities of various products and services categories are reflected in the country's trade flows. They show that overall trade patterns do reflect the relative factor endowments of the countries under investigation. While some countries exhibited counter-intuitive results such as large trade surpluses in unskilled labour for the United States and Japan and large capital surpluses in China and Malaysia, the majority of OECD economies have larger stocks of capital and skilled labour and show relatively intensive use of these factors in their traded goods and services. SEMs have large stocks of unskilled labour and show strong trade surpluses in goods and services using this resource intensively. In this sense, they show that factor content of trade, as measured via factor services, provides useful insights into trade patterns, as predicted by the comparative advantage trade theory.

However, Stone *et al.* show that accounting for imported intermediate inputs is important in analysing the factor content of trade. For example, some sectors are shown to move from deficit to surplus (and *vice versa*) when the factors embodied in imported intermediate inputs are accounted for. This is a reflection of the changing nature of trade, driven by an increasing mobility of factors, supporting the forces of production fragmentation and offshoring. It also implies that factor content patterns are undergoing fundamental changes calling for more careful analysis of the broad measures used in trade. Trade patterns seem to be now just as reliant on the cost of moving goods and changing tasks, as they are on the particular endowment structure of an economy. More generally, policy makers need to take into consideration the methods used to derive the value for trade balances. Those values based on traditional approaches are more of a reflection of historical investments and could lead to "lagging" policy advice, based on past behaviour, rather than the forward looking advice needed to steer an economy into the future.

Another challenge for policy makers highlighted by Stone *et al.* is the need to reconcile the seemingly opposing trends of the domestic (i.e. geographic specific) determination of employment and wages with the international (i.e. non-geographic specific) determination of the movement of goods and services and location of tasks. Thus, policy makers should appreciate the limits of using trade policy to influence domestic issues. Rather they should implement proactive measures, such as greater investment in resource markets through training and education and ensuring well functioning capital markets that create an environment conducive to taking full advantage of these trends. This is a theme returned to throughout this volume.

What kind of policies support a dynamic comparative advantage?

As the contrasting examples of the trade liberalisation, infant industry protection and targeted industrial policy illustrate, policy implications of the comparative advantage theory are not always clear. Following the precepts of the theory, any interference with comparative advantage, even if it entails government support to sectors in which a country may have 'natural' comparative advantage, can reduce gains from trade or even render them negative (e.g. Chapter 1). However, as pointed out by Rodrik (2009) even broad policies, not focused on any particular sector (e.g. education or capital market policies), can influence conditions and bias the development of certain activities. What is then the "natural" comparative advantage? Is it possible for a government to influence its comparative advantage in a fashion that is sustainable and beneficial for the country and the world trading system?

Understanding the interaction between policies – both trade policy and complementary policies – has become more challenging as the factors driving world commerce have grown more complex. Inter-industry trade in final goods and services with complete specialisation was a relatively straightforward matter and patterns of trade tended to be long-lived. In today's world, complex global supply chains have caused intra-industry trade to grow exponentially, with an estimated 70% of total trade now taking place in intermediate goods (Miroudot *et al.* 2009). The rapid pace of technological change means that comparative advantage is shifting rapidly. Trade theories have evolved quickly to keep pace with these changes, but the intricacies of these theories have turned effective policy-making into a non-trivial matter.[3]

To shed light on these dilemmas the second part of the book focuses on the role of broad policies in influencing comparative advantage. That is, Chapters 6 to 10 focus on the role of policies that do not target any particular sectors but rather reflect broad public choices or seek to enhance general resource endowments, even though they may indirectly favour some sectors. These broad policies are a potential source of comparative advantage and thus of welfare gains from trade. Given the lack of conclusive evidence on the viability of targeted industrial policies in sustainably influencing comparative advantage, we exclude the discussion of these policies as ones potentially hindering or reducing the gains from trade.

The comparative advantage theory emphasises the relative differences in productivity between countries as the reason for international trade and hence for gains from trade. The larger the differences in underlying sources of comparative advantage across countries, the larger the gains from trade. In Chapter 6, Kowalski presents empirical analysis that builds on recent generalisations of theory and empirics of comparative advantage (e.g. Costinot, 2009; and Chor, 2010). The chapter quantitatively assesses the relative importance for bilateral trade flows at the industry level, with particular focus on how policy and institutional factors affect resource markets, thus potentially influencing these productivity differentials. The chapter focuses on the interactions between country and industry characteristics that together form the basis for comparative advantage. The overall results highlight the importance of broad-based policies in explaining a country's export flows.

Focusing on policies affecting resource markets, the chapter shows that comparative advantage remains an important determinant of trade. For example, capital-to-labour ratios are at least as important in explaining industry patterns of trade as is geographical distance. The cross-country differences in secondary and tertiary education provide approximately half of the explanatory power as distance, while the broader indicator of average years of schooling has twice the explanatory power as the distance variable. Other important sources of comparative advantage include the availability of credit and primary energy supply while regulatory quality and labour market rigidity tend to influence trade patterns less significantly. Comparing jointly across the OECD and SEM groupings Kowlaski finds that cross-country differences, and thus the potential for gains from comparative advantage-driven trade, decreased for such sources of comparative advantage as: physical capital, average years of schooling, tertiary education, primary energy supply, availability of credit; while they increased for secondary education and regulatory quality.

The OECD grouping has become more homogenous as far as many comparative advantage sources are concerned, implying that the potential for comparative advantage-driven North-North trade may be diminishing. The non-OECD grouping, in addition to being generally more heterogeneous, displayed no clear tendency for cross-country differences to diminish over time, indicating a persistently high potential for comparative advantage-driven South-South trade. The widening differences between OECD and non-OECD economies for physical capital, availability of credit or regulatory quality suggest an increasing potential for comparative advantage-driven North-South trade along these lines. However, differences between OECD and non-OECD have narrowed for human capital indicators. Overall, the author argues that these results suggest that comparative advantage has been—and is likely to be in the future—relatively more important for North-South and South-South trade than for North-North trade.

So if these broad-based policies tend to explain comparative advantage trade, what about more specific policies? Many countries have instituted a range of policies to encourage exports, attract FDI, and promote specific industries or sectors in pursuit of growth and development. While some policies, such as building roads and ports are relatively 'neutral', and thus not controversial, others are more problematic. Policy neutrality does not mean free trade or a common tax structure for all industries. Optimal tax theory and practical fiscal considerations imply that countries will often want to rely on tariffs as a source of revenue. Indeed, in his generalized rendition of comparative advantage, Deardorff (1980) shows that gains can still be made in the presence of tariffs and export taxes. But are policy interventions beyond those associated with optimal taxes or revenue constraints justifiable? Especially for poor developing economies?

The hundreds of studies on trade policies, trade shares, productivity and growth reviewed in Harrison and Rodriguez-Clare (2009) show a strong correlation between increasing trade shares and country performance but no significant correlation between tariffs on final goods and country outcomes. Instead, interventions that increase exposure to trade are likely to lead to higher welfare gains than other types of intervention (tariffs or import substitution for example).

Stone and Shepherd, in Chapter 7, present evidence that dynamic gains from trade derive from the importation of intermediate and capital goods. The chapter establishes that dynamic gains from trade can be an important conduit for increased firm-level innovation and productivity, both key components of economic growth. The chapter builds on previous research on the dynamic gains by moving beyond a single country basis to examine impacts on firm-level productivity for a cross-section of countries. It also explores the specific impacts of broad, or complementary, policies on firms' ability to realise dynamic gains. Imports of intermediate and capital goods are associated with increased productivity in firms, while results for innovation are not as pervasive. Importantly, it finds that a range of complementary policies affects a firm's ability to generate productivity gains from intermediate and capital goods imports. Access to skilled labour is a particularly important policy variable with respect to the productivity gains of the import of intermediate goods, followed by access to finance, while macroeconomic stability slightly outranks access to finance for capital goods importers. The importance of access to finance has particular policy significance given the wide-spread financial reforms being discussed or underway.

In order to gain some insight into a country's capacity to target specific industries to help "promote" comparative advantage, Stone and Shepherd examine the ability of policies to affect productivity gains by sector. The general finding is that sector-level response varied widely and is best understood only after-the-fact. That is, those industries which one would expect to gain the most from policy support did not always show the strongest gains. For example, light manufacturing showed the strongest productivity gains from imported intermediate goods, but nothing for capital goods imports. While textiles and leather were strongly affected by equipment imports, they were unaffected by intermediate goods. Not all sectors experienced the same innovation from imports. For example, electronics had a strong positive relationship while light manufacturing showed no statistically significant relationship at all. The results illustrate the complications involved in successfully implementing so-called targeted policies.

However, there has been evidence put forth of the success of targeted policies. Rodrik (2006) argues that government policies helped China to acquire domestic capabilities in consumer electronics that would most likely not have been developed in their absence. That is, static inefficiency costs were overcome by policy, favourably affecting Chinese growth. The idea behind this 'special industries' argument is that what matters most for future growth and development is not volume, but quality. However, Rodríguez-Clare (2007) showed that externalities are not necessarily intrinsic to sectors themselves, but rather to the way they are organised. For example, import substitution may expand the manufacturing sector but if production takes place in unsophisticated ways and no clustering benefits materialize, there is no justification for policy to alleviate so-called externalities and thus lead to welfare gains.

Chapter 8 addresses the "special industries" argument by examining the patterns of trade in advanced technology products (ATP). Deason and Ferrantino argue that even those industries which are touted as promising to have the 'right' technology – i.e. their adoption would allow economies to move up the production ladder or "leap frog" development stages - are themselves anomalies and thus cannot provide a means of importing ready-made comparative advantage. In addition, many of the technologies developed in ATPs are not easily adopted across economies. So the strategy of acquiring technological capacity through industrial policy is not always pragmatic. Indeed, successful diffusion (distribution of the location of a given export over a wider group of economies) and downstreaming (shifting of the location of a given export to lower-income economies) through product cycle suggests the movement of nation-specific technology is an indication of the pre-existence, rather than acquisition, of comparative advantage.

Deason and Ferrantino present and analyse patterns of trade for a number of technology-intensive products, including ATP, for a group of 15 economies in Asia, Europe, and the United States. The chapter finds that the degree of downstreaming is highly sector-specific and product-specific; e.g. there has been more downstreaming of electronics than chemicals, of consumer electronics than electronic components, and of certain basic chemicals than specialized products such as photographic film and cosmetics. The exports of many products not normally considered to be ATP continue to be concentrated in high-income economies. The authors argue that China's export of ATP can be traced to three types of policy initiatives: the encouragement of FDI; the encouragement of processing trade (including importing intermediates goods); and the development of special economic zones. In other words, they implemented broader and not industry or sector specific, policies. The chapter concludes that it would not be possible, *a priori*, to predict which goods would be subject to rapid adoption and exploitation on comparative advantage grounds.

Thus, the results of Kowalski in Chapter 6 and Deason and Ferrantino in Chapter 8 suggest that maintaining or developing competitiveness in a certain area—for instance capital-intensive sectors—is best achieved developing effective broad policies that facilitate resource flexibility and accumulation. For example, in the case where a country succeeds in increasing its endowment of capital, relative to other countries and other factors of production, this is likely to result in the re-orientation of its exports toward capital-intensive sectors. Importantly, a broad-based approach involves a lower risk of reducing welfare gains from such specialisation, compared to policies involving direct support to capital-intensive sectors, though we certainly cannot exclude the possibility that the overall costs of such an approach exceed the benefits.

Acquiring comparative advantage in technological goods implies an ability to ascertain all of the advantages of this acquired technology, which depends on things like the size of adjustment costs and ability to absorb technologies. Policies, and government resources, shouldn't be used to acquire advanced technologies with perhaps limited spillover benefits – limited due either to the nature of the technology or the ability of the local economy to benefit from it. Rather, emphasis should be on the importance of protecting innovation (e.g. through patents) through supporting basic research at universities and underwriting risk and coordination of pioneer firms. Cavazos Cepeda and Lippoldt show in Chapter 9, how a strong IPR regime is beneficial to the accumulation of capital and technological progress.

Chapter 9 considers empirically the relationship between change in the protection of intellectual property rights (IPR) between 1990 and 2000 and the evolution of technological achievement for a broad sample of OECD countries. In order to understand how it may impact on a sector's ability to acquire a comparative advantage they also examine the relationship of such achievement to changes in labour productivity. By looking at the potential influence of IPRs on the ability of innovators (and subsequent rights holders) to appropriate benefits from their innovations, the authors argue, they can say something about the economic incentives for the application of improved technologies in the economy (e.g. from domestic innovation and technology transfer from abroad, including via trade and foreign direct investment), with potential implications for productivity and, ultimately, comparative advantage. The results point to a positive and statistically significant relationship between indicators for protection of patent and trademark rights and technological achievement. The relationship between such technological achievement and labour productivity was positive and significant in certain specifications.

Policies protecting IPR have the potential to spur innovation and productivity and can lead to the development of comparative advantage. This is a dynamic view of policy in which creating the right economic atmosphere (creating the right incentives) spurs firms to innovate without regard to a specific industry or output. Instituting such policies can instigate a dynamic process of comparative advantage. Whether comparative advantage is driven by technology or factor endowments does not change the fact that these forces change over time. Basic factors such as capital can become advanced technology; simply labour can become human capital. These more productive resources promise higher income and thus growth for economies. Cavazos Cepeda and Lippoldt show how changes in IPR protection are associated with change in indicators for innovation, technology transfer, trade and foreign direct investment. As such, these policies can facilitate the gradual accumulation of knowledge capital in firms, sectors and economies. Thus, reform of inadequate IPR protection may be cited as one part of a general strategy for promoting certain comparative advantage without resorting to a "special industries" type approach.

From a different vantage point, in Chapter 10 van Tongeren takes up the question of export restrictions in the context of special industries. The chapter examines the recent resurgence of export restrictions and their impact on trade. This resurgence has alerted policy makers to the challenges of rapid industrialization and population growth and its increasing pressure on raw material supplies. Restrictions can take a variety of forms including export taxes and quotas, licensing requirements, dual pricing schemes, local processing requirements, state trading enterprises and outright prohibition. Restrictions divert raw material supplies to domestic markets, providing downstream industries with a cost advantage and limiting supply to world markets. However, it is often not the access to raw materials (often a relatively small input cost) which holds back production in downstream industries but domestic market failures. Thus, this chapter argues, these restrictions are inefficient because they are put in place to overcome domestic market failures which are better addressed through non-trade instruments. Attempts to use export restrictions to undo the effects of tariff escalation are counter-productive. That is because the economic impact of export restrictions usually manifests itself in the form of higher import prices as well as leading to counter-productive bandwagon effects. Export restrictions thus more regularly harm the trade position of these same economies imposing them. Restrictions also divert more supply to domestic market, depressing domestic prices. There develops a gap between domestic and world prices that can encourage fraud or illegal shipments. The chapter shows how restrictions at best, do not meet their stated objective and at worst, do actual harm to the imposing economy.

As noted throughout this volume, specializing in comparative advantage industries leads to gains from trade by effecting a more efficient division of labour. Trade liberalization – whether done in the multilateral framework of the WTO or unilaterally – acts through a variety of channels to improve the competitiveness of the economy and the aggregate wealth of its citizens. This competitiveness in turn derives in large part from the reallocation of factors of production from less efficient to more efficient sectors. This process of structural change is not a simple one; the longer it takes, the greater the economic cost of short-term unemployment of resources. Importantly from a political economy perspective, it leads to "job churn" with workers moving within and across sectors, leading to short-term and potentially structural (long-term) unemployment. Often the most vulnerable workers bear a disproportionate burden of the associated costs. Hence, while economists see trade-induced structural change as being a necessary and salutary process of evolution, many social actors lament it and work to resist it. This is particularly true in the context of an economic downturn. As the 2008-09 crisis has been the worst since the Great Depression, protectionist forces – allied against this process of structural change – have arguably been at their strongest in over seven decades. It took a great deal of political will to eschew this pressure. Note, however, that while there was technically no great protectionist backlash in terms of deeds, there has been in words, and we have not yet reverted back to the liberalization trend of earlier years.

Hence, focusing on structural change is important for economic, political-economy, and social considerations. In the final chapter, Chapter 11, Petri and Plummer offer a forward-looking policy chapter on a two-fold approach to welfare maximization. The first is for governments to pursue wide-ranging liberalisation of international trade and investment flows that allow a country to realise its comparative advantage. The second is to put in place a mix of structural policies that will allow a country to efficiently adjust to the changes that accompany this liberalisation. The chapter discusses various approaches to liberalisation, arguing that a multilateral approach on a most-favoured-nation basis is best, but that significant advancement could be made through regional agreements or concerted liberalisation. Policies needed to support structural change fall into two broad categories. The first includes policies that facilitate shifting resources from old to new areas of comparative advantage. The second are policies that raise productivity or improve factors of production in areas favoured by comparative advantage. The inevitable costs that come with trade liberalization can be reduced if governments embrace policies that speed the adjustment process and support efficient change. By focusing on policies that support structural adjustment, governments can avoid some of the pitfalls experienced in the past where policy was seen as an anecdote to markets. However, this chapter cautions policy makers against going to the other extreme and relying too heavily on markets. Governments need to use a balanced approach between policy and markets to facilitate these structural changes.

Conclusions

What we can draw from the studies included in this volume is that comparative advantage matters: trade is still consistent with its broad mandates and policy can have an influential role in determining outcomes. Trade and FDI have generated the greatest welfare gains when they are associated with an economy's increasing exposure to trade. This includes imports as well as exports. While there is some evidence that particular countries (such as China) and sectors (such as certain electronics) have characteristics that imply a greater, more intrusive role for policy, these situations are exceptions rather than the rule. Basing a trade policy strategy on these high profile, yet exceptional, examples, would lead to welfare losses and unrealized gains from trade.

The evidence provided here underscores the importance of a comprehensive approach to designing economic policies, which should seek consistency between trade and other policy objectives. Governments should avoid attempting to actively affect trade patterns in general, but such actions may be particularly counterproductive if they are inconsistent with a country's resource base or other policies in place.

Thus, when seeking to maintain or develop competitiveness in a certain area – for instance, capital-intensive sectors – this is best achieved through drawing on best practices and developing effective broad policies that facilitate capital accumulation. Importantly, a broad-based approach involves a lower risk of reducing welfare gains from such specialisation, compared to policies involving direct support to capital-intensive sectors, and we certainly cannot exclude the possibility that the overall costs of such an approach exceed the benefits.

The finding that comparative advantage has been evolving together with policies and institutions does not imply that countries should try to actively influence it. Our results confirm that it is the differences between countries, including differences in policy settings and policy performance, that create relative differences in productivity and give rise to trade and gains from trade. Some of these differences in policy settings may reflect different stages of economic development, but some may also reflect strategic policy choices such as investment in human rather than physical capital. This does not mean that countries should not try to catch up with their best performing peers if they wish so, but it emphasises that comparative advantage-based trade yields benefits even at the early stages of such a catching-up process. More than anything, this implies that trade openness and comparative advantage-driven specialisation is not a constraint to the economic development process but rather its catalyst.

Notes

1. This publication concludes the work undertaken by the OECD Trade Committee under the theme Effects of Globalisation: Openness and Changing Patterns of Comparative Advantage. It was edited by Przemyslaw Kowalski and Susan F. Stone, but is the fruit of a team effort of several staff in the Development Division of the OECD Trade and Agriculture Directorate which had the lead in the project. Several chapters are based on material that benefited from comments and guidance of the Working Party of the Trade Committee, participants to the OECD Global Forum on Trade in Chengdu, China, as well as an internal OECD workshop with the participation of representatives from Brazil, China, India, Indonesia and South Africa. This publication would not have been possible without excellent statistical assistance by Clarisse Legendre and editorial assistance by Michèle Patterson.
2. Selected emerging market (SEM) economies group 56 countries that cover all the OECD Enhanced Engagement (EE) countries (Brazil, India, Indonesia, China and South Africa), Russia (which has the status of an accession country in the OECD) as well as other major emerging economies, such as Argentina, Hong Kong, China, Chinese Taipei, Thailand, Singapore, Morocco and Tunisia. In some cases, however, country coverage varies depending on data availability.
3. For example, the Helpman (1987) model allowing monopolistic competition, Eaton and Kortum's (2002) multi-producers of the same good and Melitz's (2003) model of firm heterogeneity all add layers of complexity to the potential outcomes predicted by trade theory.

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Part I.

Is comparative advantage still relevant today?

Chapter 1

Comparative advantage: The theory behind measurement

by
Alan V. Deardorff[1]

Three approaches that have been used empirically, each represented in this volume, are reviewed in this chapter to provide information about the patterns and causes of comparative advantage. Revealed comparative advantage, factor content of trade and the gravity model of trade each provide useful information, even if none of them is capable of fully delineating either the nature of comparative advantage or its causes. They can illuminate comparisons across countries that may be suggestive of directions for further research.

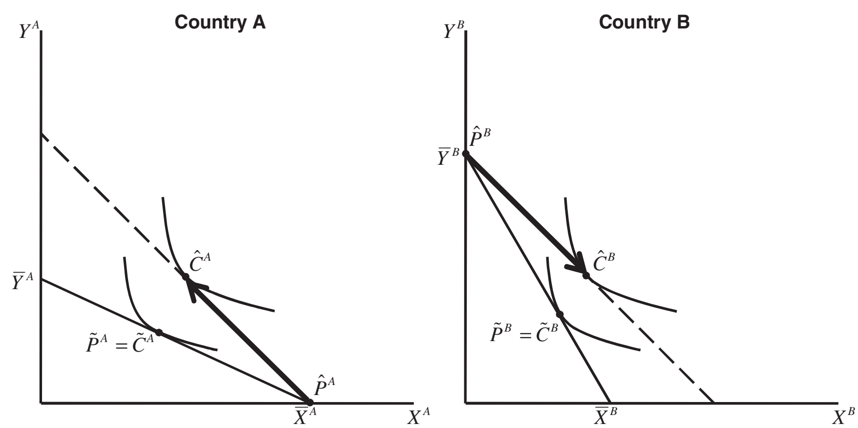
From the earliest days of economic science, economists have sought to explain why countries engage in international trade as well as what they trade – that is, which goods (and, more recently, services) they export and which they import. Fundamental to that understanding has been the concept introduced by Ricardo (1815) of comparative advantage. Ricardo recognized that, while differences in countries' abilities to produce goods – productivity – lie at the heart of international trade, it is not absolute differences but relative differences that matter. That is, a country will not necessarily be unable to export a good just because some other country is able to produce it more efficiently, using less labour, say, per unit of output. If in spite of its low productivity in that particular good the country has even lower productivity in all others, then its wage will be low enough to offset its productivity disadvantage. It will export the good successfully (assuming costs of trade, such as transportation, are low enough that there is any trade at all).

This insight lies at the heart of much of the international trade theory that has appeared in the two centuries since Ricardo wrote. Other explanations of trade do exist (economies of scale, product differentiation, etc.) and undoubtedly help to explain the rich variety of international trade that exists in the world. But most advances in international trade theory have built upon, rather than dispensing with, the concept of comparative advantage. Most notably, the Heckscher-Ohlin theory of international trade due to Heckscher (1919), Ohlin (1933), and Samuelson (1948) elaborates the causes of comparative advantage in terms of factor endowments and factor intensities, thus giving a better understanding than Ricardo was able to provide of why countries have comparative advantage in the sectors that they do. Other researchers have gone on to identify, both theoretically and empirically, many other contributors to comparative advantage, going well beyond factor proportions.

The Ricardian trade model

Closely associated with Ricardo's insight, and indeed intimately connected with its validity, is the proposition that countries gain from trade. Both are illustrated most starkly in the standard diagrammatic depiction of the Ricardian trade model shown in Figure 1.1. Here two countries, A and B, are each able to produce two goods, X and Y, using a single factor of production, labour. Because each country has a fixed endowment of labour and a fixed (but different) quantity of labour required per unit of output, their production possibilities are represented by the straight lines $\overline{X}^I\overline{Y}^I, I = A, B$. The line for country A is drawn flatter than the line for country B, indicating that the relative cost of good X is smaller in country A than in country B, and thus that country A has a comparative advantage in good X. That this need not reflect absolute advantage can be seen from the fact that the countries' labour endowments do not appear in the figure. Country A may have a much larger amount of available labour than country B, and thus require more of it per unit of either good than country B, an absolute disadvantage in production of both goods. We cannot know that from the figure, and it does not matter, neither for the direction of trade nor for the gains from trade.[2]

Figure 1.1. Ricardian comparative advantage and gains from trade



In autarky, each country must consume only what it produces. Using indifference curves to represent preferences for the goods, the countries produce and consume at the points labelled $\tilde{P}^I = \tilde{C}^I, I = A,B$. Their autarky relative prices are only implicit in the figure, given by the relative marginal costs of the goods and thus by the slope of the production possibility curve at the point of production. This slope, in absolute value, gives the relative price of good X, which is therefore lower in country A than in country B.

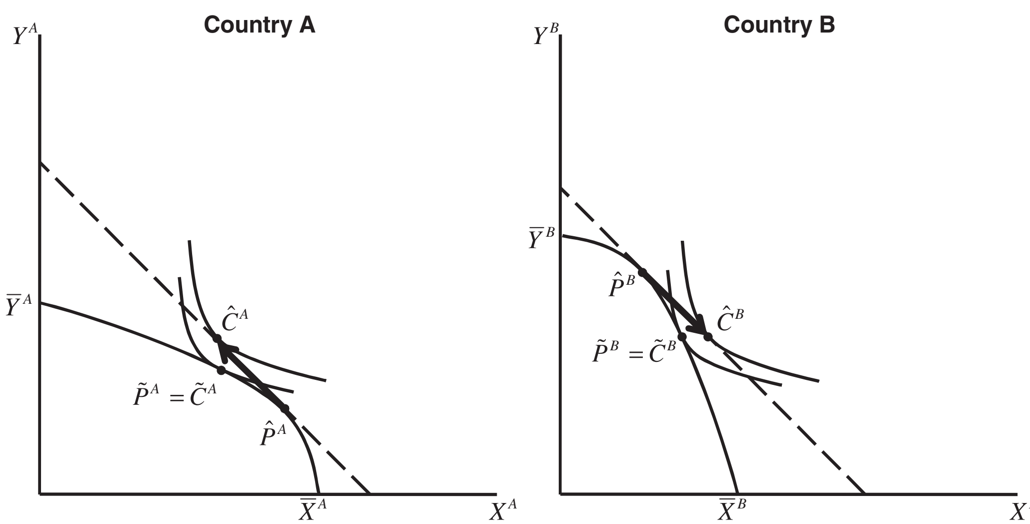
If the countries are now given the opportunity to trade freely, they will necessarily face the same prices, and producers in each country will reallocate resources toward the sector with a higher relative price. Since a common price must lie between the two autarky prices (else both would produce only the same good), free trade leads country A to specialize in good X and country B to specialize in good Y at $\hat{P}^I, I = A,B$, each producing only the good in which it has a comparative advantage. Each country then trades part of its output for the other good and reaches the consumption points $\hat{C}^I, I = A,B$. To be in equilibrium the two vectors of trade from production to consumption, shown in the figure by the heavy arrows, must have the same length. The free trade relative price—which is the common slope of these arrows—is determined by this need to clear markets.

This is the basic Ricardian result. Note that it seems to imply that each country also gains from trade. In fact, however, the causation is the reverse. That is, in order to gain from trade, the countries' trade must conform to comparative advantage, which is therefore a necessary but not a sufficient condition for gains from trade. This will appear more clearly later when we leave the simple Ricardian model and also consider policies that may distort trade.

A variable-cost trade model

Although Ricardo's insight about comparative advantage is very general, the specific model that we now call the Ricardian Model is very special, with its constant labour productivities. A more general model is shown in Figure 1.2, where the production possibility frontiers (PPFs) are labelled as before but are now curved, bowed outward. This curvature could reflect several causes, including diminishing returns in a specific-factors model, but it is most often taken to represent the interaction of factor endowments and factor intensities in a multi-factor Heckscher-Ohlin model. Thus with, say, two factors capital and labour, country A may have a relative abundance of capital and therefore production possibilities that favour the capital intensive good, X. However, as it shifts more and more of both factors into the X sector, it must rely increasingly on labour, which is less productive in producing X, and the relative cost of X rises.

Figure 1.2. Comparative advantage and gains from trade with variable costs



The variable-cost model continues to provide the implication that each country will export the good in which it has a comparative advantage, so long as that advantage is measured from relative costs (and therefore prices) in autarky. However, the model has two implications that are quite different from the simple Ricardian model. One is that the countries are much less likely to specialize in producing a single good (the Ricardian model required at least one of them to do so under free trade). The second implication is that the relative cost differences that define comparative advantage, and are the source of trade, disappear once one reaches equilibrium with free trade. That is, the two countries in the trading equilibrium in Figure 1.2 are both operating at points on their PPFs where the slope is equal to the common world relative price. Thus comparative advantage cannot be observed, in a free trade equilibrium, from relative marginal costs.

It is the gains from trade that imply that trade conforms to comparative advantage, rather than the other way around. Thus the gains from trade are at the heart of various efforts to demonstrate the more general validity of the "Law" of comparative advantage. I and others[3] have shown in much more general models than the one here that trade will conform to comparative advantage in an average sense across industries and countries, without any restriction on the numbers of factors, goods, and countries, and with almost unlimited natural and policy barriers to trade. The main restriction is that policies must not play too large a role in subsidizing a trade pattern that contradicts comparative advantage.

Note that this more general model is consistent with any of a great many theories of the cause of comparative advantage. The Heckscher-Ohlin model would attribute comparative advantage only to differences across countries in relative factor endowments, although this is open to many interpretations as to exactly what those factors are – labour, capital, human capital (or labour of various skills), land, various natural resources, etc. The Ricardian explanation of trade seemed to attribute it to differences in technology. These too are consistent with the variable cost model, and indeed have found considerable empirical support alongside the factor proportions explanation. But in addition to these two major stories about the sources of comparative advantage, recent work has introduced other sources, such as differences in institutions of various sorts, differences in climate, differences in culture, and so forth (see also Chapter 6). Thus the concept of comparative advantage has continued to be central to international trade theory, even though it has been elaborated and explained in a great many ways.

Measuring comparative advantage

Given this theoretical underpinning, one might have hoped that the measurement of comparative advantage would be straightforward. In fact it is not, and for reasons that are readily understood from the theory. The best definition of comparative advantage is in terms of autarky relative costs, and of course these are almost always impossible to observe, since countries have long been engaged in trade.[4] Observable relative costs in the presence of trade either have been equalized as a result of trade, as in Figure 1.2, or they differ as a result of trade costs in ways that primarily indicate those costs. Therefore direct observation of relative costs has seldom been successful as a measure of comparative advantage.[5]

Several other approaches have therefore been used, none of which get exactly at comparative advantage, but each of which is nonetheless informative in various useful ways. The approaches taken in the subsequent chapters of this volume illustrate this diversity, and they will be discussed here individually. They are: revealed comparative advantage; factor content of trade; and the gravity model of trade.

Revealed Comparative Advantage (RCA)

The idea here is simply to assume that trade conforms to comparative advantage and use trade itself to indicate what comparative advantage is. This was suggested, named, and defined by Balassa (1965), comparing a country's share of world exports in a sector to its share of exports overall:

$$RCA_{ij} = 100 \frac{X_{ij} / X_{wj}}{X_{it} / X_{wt}}$$

where X_{ij} and X_{wj} are exports of good *j* by country *i* and the world, and X_{it} and X_{wt} are their total exports. In words, this ascribes to comparative advantage the fact that a country exports more of a good than one might expect based on its and the world's total exports.

This is an intuitively appealing idea that has never been formally shown to be valid within a theoretically consistent trade model, largely because those models have rather extreme implications for specialization, as illustrated in Figure 1.1 for the Ricardian model. Heckscher-Ohlin models retain some of that property when expanded to many goods and factors, especially when the number of goods exceeds the number of factors as is necessary to conform to plausibly available data.[6]

This difficulty might be overcome with the more recently developed modelling approach of Eaton and Kortum (2002), who allow a continuum of productivities to exist within a country and industry and who therefore generate a prediction for trade that varies more smoothly with prices and wages than more conventional models. Indeed, this approach has recently been taken to both modelling and measuring comparative advantage by Levchenko and Zhang (2011) in what promises to be a more direct approach to measuring comparative advantage than the RCA approach. However, it seems plausible to me that this Eaton-Kortum approach might be used to derive something very like the RCA prediction under free and undistorted trade.

Unfortunately, if trade is distorted by policies, then the actual trade flows included in RCA may reflect those distortions as much as or more than any underlying comparative advantage. This limits the usefulness of RCA.

What can RCA measurements be used for? Certainly they can be used for the descriptive purpose of identifying in which sectors a country exports more or less than average (e.g. Chapters 3 and 4 in this volume). The comparison to world exports in the formula for RCA serves the useful purpose of normalizing the trade data for the sizes of sectors and countries, which otherwise might give misleading impressions of the importance of a sector and country in international trade.

RCA can also be used, together with other data, as a guide to what causes actual trade patterns, whether these are driven by comparative advantage or not. Thus RCA indexes could be correlated with additional data on factor endowments and factor intensities to learn whether the Heckscher-Ohlin explanation of trade has significant explanatory power. This is done to a certain extent in Chapter 3 where developments in RCA indices are analysed for separate product groups classified according to the intensity with which they use unskilled labour, human capital or technology across a group of OECD and non-OECD countries. To the extent that differences in total factor productivity can be measured, these could also be related to RCA to see if a more strictly Ricardian explanation of trade patterns plays an important role.

Finally, since policies can influence trade patterns, data on trade policies could be combined with RCA to determine whether trade patterns are correlated with trade policies. For this purpose, the fact that RCA normalizes trade flows by total trade might make it a more accurate indicator than gross trade flows. Similarly, other policies that may not be intended to influence trade, but that might do so unintentionally, could also be correlated with RCA in this way.[7] In both of these policy cases, one should not assume that a causal relationship extends from policy to trade, rather than the reverse or the possibility that both are influenced by some third cause.

Another use of RCA might be to identify sectors that gain or lose from trade, perhaps in order to target assistance to those affected. Presumably sectors with an RCA of less than 100 might be viewed as more vulnerable to displacement by imports in response to trade liberalization than those for which RCA suggests a comparative advantage. This would be useful to know when configuring policies to deal with hardship in industries on an industry-specific basis.

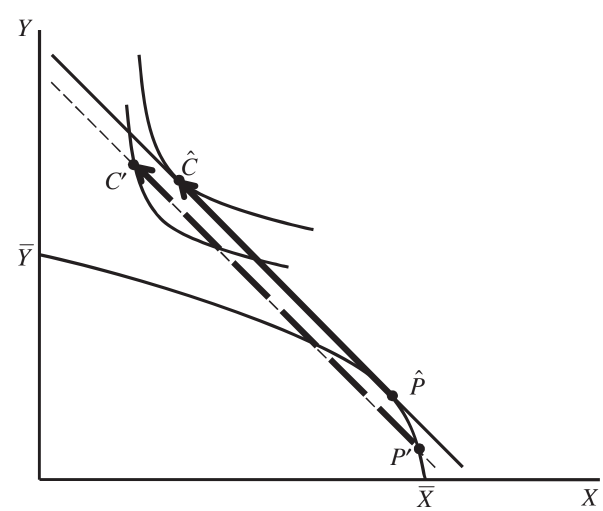
Some might be tempted to use RCA as an indicator of which industries should be the target of export promotion policies, such as subsidizing production and/or exports. To the extent that policy makers accept that trade in accordance with comparative advantage is beneficial, they are likely also to believe that increasing the amount of trade increases those benefits. This, however, is problematic.

First, the conclusion is even potentially valid only if RCA provides a correct diagnosis of the sectors in which a country has true comparative advantage. But as already discussed, this is not necessarily the case. Existing policies can easily distort trade and cause a country to record an RCA index greater than 100 in spite of a true comparative disadvantage. This is most obviously possible of policies that, say, subsidize production of what would otherwise be high-cost goods – not an uncommon practice, especially in agriculture. It is also possible, however, without subsidies. If taxes or other impediments happen to be highest in the sectors where true comparative advantage lies, then exports there will be depressed, leaving other comparative-disadvantage sectors to dominate the RCA index.

In either case, then, export promotion policies targeted on the basis of RCA would be expected to make the country worse off. Their effect would be to reallocate resources from relatively low-cost sectors to relatively high-cost sectors. That cannot be good.

On the other hand, even if RCA were known to correctly diagnose comparative advantage, one should be wary of any policy implications. A subsidy to increase exports of a good, even though it is a good in which the country has comparative advantage, will actually lower welfare. This is shown in Figure 1.3 where, starting from free trade, an export subsidy causes welfare to fall.

Figure 1.3. Effects of an export subsidy to the comparative-advantage good, X



In the figure, a small country starts with free trade, producing at $\hat{P}$, consuming at $\hat{C}$, and trading along the heavy solid arrow. A subsidy to exports of good X raises its price within the country, causing production to move to P', consumption to C', and trade to the dashed arrow. Welfare falls from the higher to the lower indifference curve. Thus, even though the country has a clear comparative advantage in good X, it loses by subsidizing its exports. So even if RCA were successful in identifying comparative advantage correctly, it would not serve as a useful guide to policy in this case where trade is already free and therefore optimal.

One might argue that, even though trade may be free, there are costs of trade such as transport costs that prevent a country from achieving the optimum shown at $\hat{C}$ in Figure 1.3. In that case, surely, if RCA can identify the comparative advantage good, then subsidizing its exports would be beneficial.

This is not the case. Although I will not attempt the rather messy analysis here, if trade is reduced by the presence of real trade costs, then that reduction is in fact optimal. To artificially promote trade with an export subsidy would force the country to bear those trade costs excessively, and welfare would again fall.

One might also object to other assumptions made in Figure 1.3. What if the country is not small, but instead large? That just makes the subsidy worse, since it will push down the world price of the export good, worsening the country's terms of trade.[8] What if the policy were a production subsidy rather than an export subsidy? That would indeed be better than an export subsidy, since it would not distort consumer choice. But production would still move to a point like P', reducing the value of the country's output at world prices and making even undistorted consumers worse off.

In short, even if RCA can correctly identify the sector or sectors in which a country has comparative advantage, it is not clear that this information can be useful for policy purposes. If a tool exists that can identify true underlying comparative advantage even when it is not reflected in actual trade, then that might be useful as a guide to removing whatever barriers prevent comparative advantage from being exploited. But RCA by its nature only captures comparative advantage if it is already reflected in trade. And in that case it is not clear that there is anything more to do with policy.

The factor content of trade

A second method of learning something about comparative advantage empirically is to measure the factor content of trade. Most simply, this consists of first ascertaining the quantities of the various m factors of production that are used to produce one unit of each of the n goods that enter into international trade, in the form an $m \times n$ matrix, F. This matrix is then multiplied by the $n \times 1$ vector T of net trade in goods (exports minus imports) to obtain the amounts of each factor used to produce exports minus those used to produce imports. The Heckscher-Ohlin-Vanek version of the Heckscher-Ohlin Theorem, due to Vanek (1968) says that this vector will be positive for those factors with which the country is relatively well endowed compared to the world, and negative for others. Thus, rather than identifying goods in which the country has comparative advantage, it identifies its relatively abundant factors that, in the Heckscher-Ohlin model, underlie its comparative advantage.[9]

As an indicator of comparative advantage, this is arguably more useful than information about goods, just because there are so many more goods than there are factors. By learning that a country has comparative advantage in goods that are, say, relatively capital intensive, we may gain a better understanding of trade than if we were simply given a list of comparative-advantage goods or sectors.

The factor content of trade may also be useful for another purpose. Deardorff and Staiger (1988) showed that, under somewhat restrictive assumptions, the factor content of trade is indicative of the effects that trade has on factor prices. Thus one might infer, for example, that a country that is a net exporter of, say, capital in factor-content terms has had its return to capital increased by trade above what it would have been in autarky. Likewise, a change over time in the factor content of a country's trade may indicate how trade has altered factor prices over time.

This approach to relating trade to factor prices has been used frequently by both trade and labour economists to diagnose the extent to which trade may have contributed to the rising premium paid to skilled workers compared to unskilled workers in the United States since about 1980.[10] Some trade economists – especially Leamer (2000) – have criticized this approach as requiring assumptions that are too restrictive to be meaningful.

Gravity models

A final empirical approach to analyzing comparative advantage builds upon the gravity model of trade. In its original form, the gravity model dealt only with total trade, not its composition, and the focus was on how bilateral trade varied with country size and distance. The simplest gravity equation takes the form

$$T_{ij} = AY_iY_j / D_{ij}$$

where T_{ij} is a measure of trade between country i and country j, Y_i and Y_j are the countries' incomes, and D_{ij} is the distance between them, with A a constant. Taking logs and allowing the three explanatory variables to enter with elasticities other than one, the equation becomes

$$\log T_{ij} = \alpha_0 + \alpha_1 \log Y_i + \alpha_2 \log Y_j - \alpha_3 \log D_{ij}$$

This equation routinely fits the data remarkably well, and it does even better if a few additional explanatory variables are included, such as population (or per capita income) and dummy variables for such things as a common border or common language. Although the gravity equation did not originate with any particular theoretical model of trade, it is consistent with several of them, as discussed in Deardorff (1998).

The gravity-type model has also been derived for trade by sector, including additional explanatory variables on the right-hand-side to capture determinants of comparative advantage (e.g. Chor, 2010). The latter include relative factor endowments of countries interacted with sector factor intensities in order to capture the Heckscher-Ohlin mechanism as well as other variables that might be thought to influence comparative advantage, such as institutional variables.

This approach is somewhat *ad hoc*, since the precise estimating equation is unlikely to be derivable from a complete theoretical model of trade. In that sense it is subject to the same criticisms as early attempt to test the Heckscher-Ohlin Model such as by Baldwin (1971). On the other hand, by building on the theoretically sound gravity-equation structure, it can at least control properly for the roles of income and distance.[11] In any case, this gravity-model approach provides very useful descriptive information about the correlates of sectoral trade, and at least a suggestion of what institutions and other features of economies may influence the pattern of trade. Chapter 6 in this volume builds on Chor (2010) and on other insights from the literature on specific sources of comparative advantage to quantitatively assess their relative importance for bilateral trade patterns at the industry level, with particular focus on policy and institutional factors.

Conclusions

Three approaches that have been used empirically, each represented in this volume, are reviewed in this chapter to provide information about the patterns and causes of comparative advantage.

Revealed Comparative Advantage gives the most explicit information about which products a country exports either more or less than average, and it thus provides quite a complete mapping of what a country's patterns of trade actually are. This does not tell anything about what the underlying forces generating that trade may be, however, unless one is certain that no such forces are operating except true comparative advantage. If that were the case, then further information about comparative advantage might not be needed or useful. Nonetheless, RCA is a useful tool for describing trade, and it can illuminate comparisons across countries that may be suggestive of directions for further research.

The factor content of trade, in contrast, focuses exclusively on one particular source of comparative advantage: factor proportions. By measuring the quantities of factors embodied in exports and imports, factor content calculations allow us to see the role that factor endowments and intensities have played in forming trade patterns. This approach is particularly useful as a guide to how trade, and changes in trade, may alter factor prices. The latter in turn are fundamental for understanding changes in the distribution of income.

The gravity model provides a third approach to studying trade patterns, one that has not until recently been used for this purpose because most gravity estimations have been done at the aggregate level. By disaggregating trade and then incorporating various hypothesized determinants of comparative advantage in a gravity equation, however, one is able to gauge the contributions that these determinants may make to the pattern of sectoral trade.

Thus each of these methods provides useful information, even if none of them is capable of fully delineating either the nature of comparative advantage or its causes. The chapters in this volume, accordingly, provide a wealth of information that will be useful both for policy makers and for future researchers on trade. One might even hope that this information will provide both clues and stimulus to further research that will ultimately help us better understand the true patterns and causes of comparative advantage.

Notes

1. Associate Dean, Gerald R. Ford School of Public Policy, University of Michigan, Ann Arbor, Michigan, United States. The views expressed are those of the author alone and are not meant to represent the views of the OECD or any of its members.
2. Although it certainly matters for the real wage, and thus the income, of the country. But the low wage implied by low productivity does not interfere with the fact that the real wage will rise with trade. Quite the opposite: it is the low wage that makes both trade and the gains from trade possible in the presence of low productivity.
3. See Deardorff (1980), Dixit and Norman (1980).
4. An exception is the work of Bernhofen and Brown (2004), which used data from Japan's historical opening to international trade to confirm the role of comparative advantage.
5. Early research by MacDougall (1951) and Stern (1962) had some success looking at labour costs.
6. This is one of the problems discussed in my Nottingham and Graham Lectures, Deardorff (2005, 2006).
7. Chapter 6 in this volume addresses the role of broad policies in influencing comparative advantage and trade patterns.
8. In Figure 1.3, the price line would become flatter while still tangent to the PPF. This pushes the country to an even lower indifference curve.
9. An attractive feature of this approach is that it incorporates intermediate inputs fairly easily by use of an input-output matrix (see also Chapter 5).
10. For an early example, see Borjas, Freeman, and Katz (1991).
11. Distance should not be captured quite that simply. As noted in Deardorff (1998) and stressed by Anderson and van Wincoop (2003), trade between two countries depends not only on the distance between them, but also on their combined distance from the rest of the world, i.e. their remoteness.

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Chapter 2

Production, consumption and trade developments in the era of globalisation

by

Przemyslaw Kowalski and Ricardo H. Cavazos Cepeda[1]

This chapter characterises broad trends in production, consumption and trade over the past thirty years across the OECD and selected emerging market (SEM) countries and sets them in the context of economic and social events pertinent to international commerce. It provides a background for the more nuanced analyses of trade specialisation and its underlying drivers that follow in the subsequent chapters of this volume.

The effects of globalisation have been at the forefront of public debate in recent years, fuelled on the one hand by the perceived benefits of integrated markets, and on the other hand by concerns over excessive market volatility, the impact of trade with low-wage countries on OECD labour markets, "outsourcing," and deepening of global current account imbalances. Other pressures on the global trading system are coming from increasing claims on limited natural and environmental resources, volatility of commodity prices and stalled multilateral trade negotiations. Calls to "manage" globalisation are rising and are unlikely to subside in the aftermath of the 2008-2009 economic crisis.

The various effects of trade openness and associated policy implications have traditionally been interpreted through the lens of what international economic theory describes as a realisation of comparative advantage, although there are other theories which provide complementary inputs to this interpretation. According to this theory specialisation and trade are determined by relative productivity differences and, if these productivity differences originate in natural characteristics of countries, such specialisation generates gains from trade. Many factors, some of them more natural than others, have been identified in the literature to influence relative productivity patterns including changes in relative factor endowments, technology discoveries and adoption, targeted or sectoral policies as well as broad policies not designed primarily to influence production structure or trade flows.

In this chapter we focus on characterising broad trends in production, consumption and trade over the past thirty years and set them in the context of economic and social events pertinent to international commerce. In this way we intend to provide a background for the more nuanced analyses of trade specialisation and its underlying drivers that follow in the subsequent chapters of this volume. We sidestep the question of what might have been particular factors that shaped relative productivity differences across the OECD and selected emerging market (SEM) countries, or to what extent they can be characterised as natural.

Globalisation, trade, FDI and growth developments

Globalisation, defined as the proliferation and deepening of world trade and investment links, has undoubtedly been an important phenomenon during the last three decades. It has been driven by a combination of factors such as technological changes, reduction of trade and communications costs but also domestic and trade reforms across the world. Innovation in the area of information and communication technology and transport broadened and deepened the interdependence between economic actors based in different countries by narrowing the divide of distance and enabling a greater unbundling of the production process across national borders (OECD, 2006). Costs of international commerce have also been driven down by a major opening to trade and investment of the OECD economies and many SEM economies achieved through a combination of multilateral, regional and unilateral trade liberalisation, as well as through domestic economic reforms (OECD, 2008a).

The scale and scope of the globalisation process are best illustrated by developments in international trade and foreign direct investment (FDI), both of which have been growing faster than GDP in recent decades. As a result economic activity is today more international in many respects. FDI flows have grown much more quickly than trade, income or domestic investment, starting in mid 1980s and culminating around 2000 (Figure 2.1). FDI in particular has played a fundamental role in recent international economic integration and was the most dynamic factor in industrial restructuring (OECD, 2010). Yet, mergers and acquisitions accounted for the bulk of this type of investment in the past 15 years suggesting the influence of FDI was mainly through transfer of ownership rather than creation of new business or expansion of the capacities of existing firms (OECD, 2010).

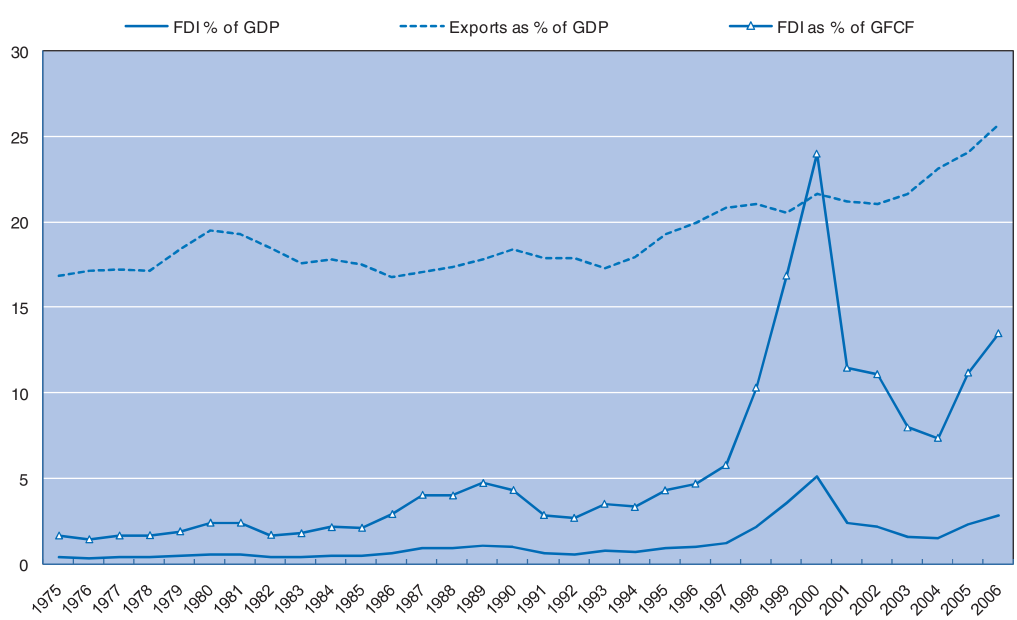
In the last two decades, the OECD area continued to be the major net exporter of direct investment capital while countries such as India and China have been prominent hosts of FDI. In recent years, however, some emerging market countries have become also a significant source of outward FDI. For example, China's accumulated outward investment flows in the period 2005-2008 exceeded those of Norway, Denmark, Ireland, Australia or Korea while India's outward flows in the same period exceeded FDI in Australia, Korea, Poland, Mexico and several other smaller OECD countries (Figure 2.2).

World trade in goods and services has grown less quickly than FDI but still faster than income (Figure 2.1). The growth was also from a relatively large base and in 2007 world exports or domestic investment (measured by value of gross fixed capital formation) still both dwarfed FDI in relative terms. Today USD 1 of value added generated in the OECD area is associated on average with approximately 28 cents worth of exports (up from 19 cents at the beginning of 1980s).

Sourcing of foreign intermediate goods has intensified with capital goods (including parts and accessories) becoming the fastest growing category of world trade (Figure 2.3).[2] Processed industrial supplies are currently the largest category though their share in total trade has been declining somewhat since the mid 1990s. Trade in consumption goods has recorded growth second only to capital goods with the highest growth rates within this category observed for non-durable and semi-durable consumption goods. The share in world trade of fuels and lubricants (mostly primary products such as crude oil) has fallen considerably despite the significant rise in the price of oil in recent years.

Figure 2.1. Trade, FDI and income growth in the OECD area, 1975-2007

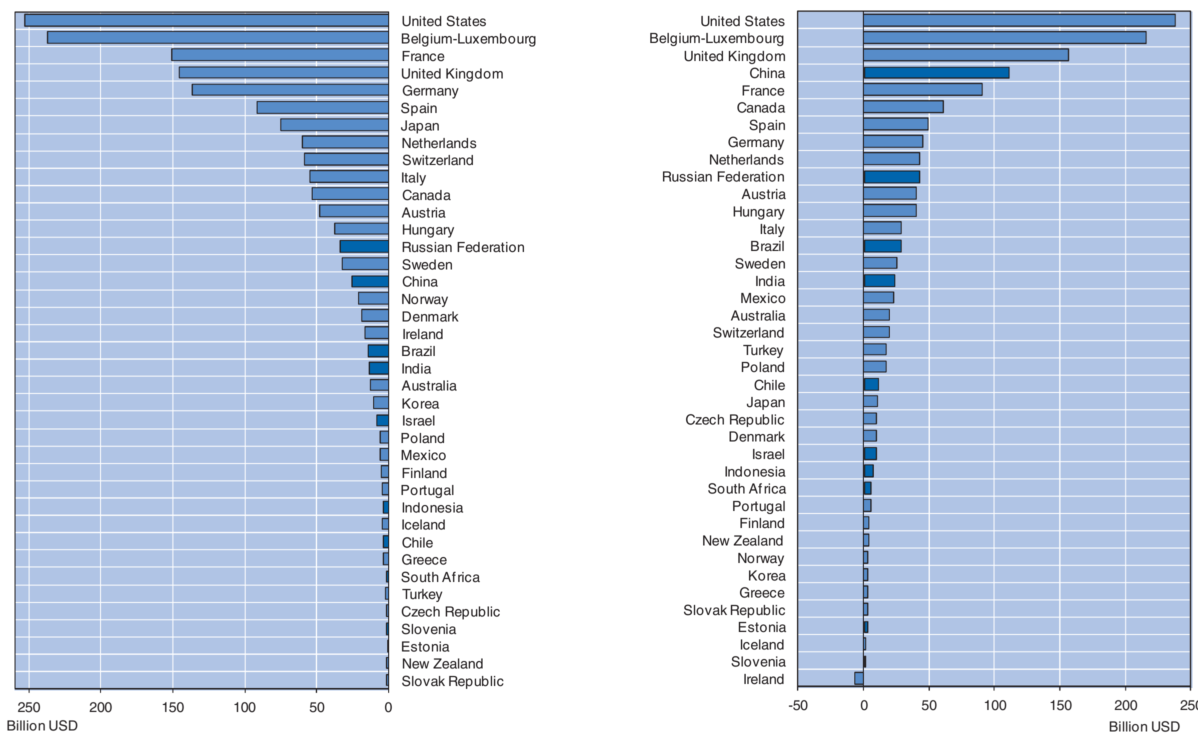
Trade and FDI as % of GDP and Gross Fixed Capital Formation



Source: World Development Indicators (WDI).

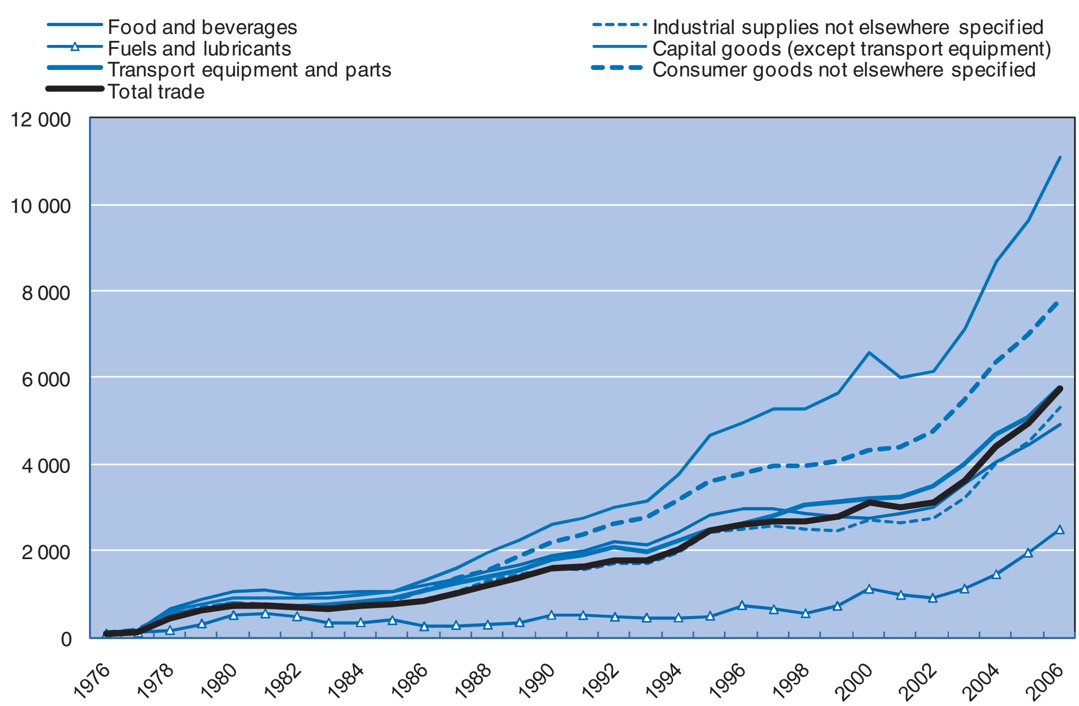
Figure 2.2. Trends in foreign direct investment

Panel A. Average assets **Panel B. Average liabilities**



Source: OECD (2010).

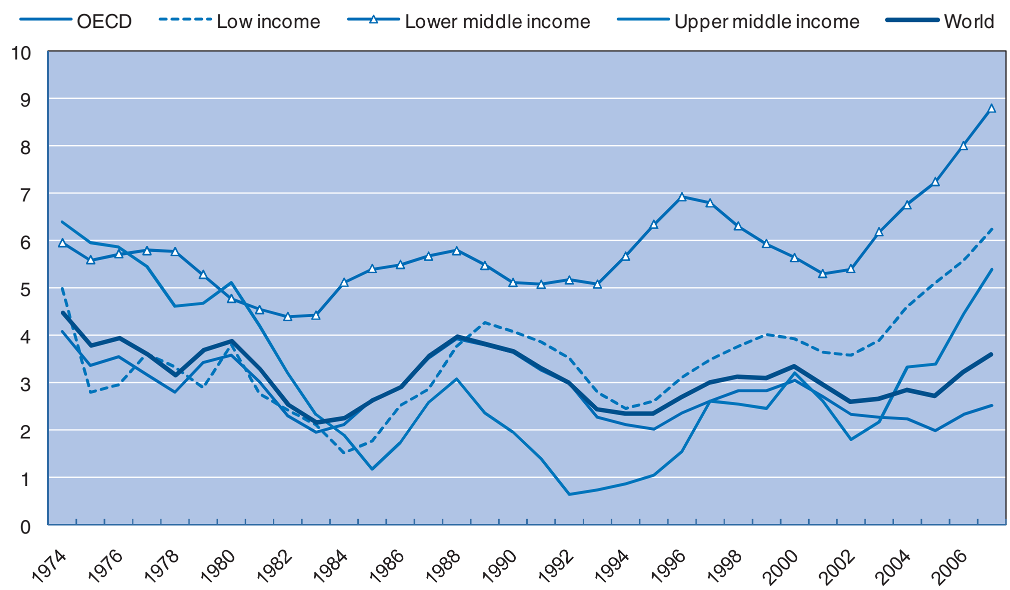
Figure 2.3. World exports by product use
1976=100



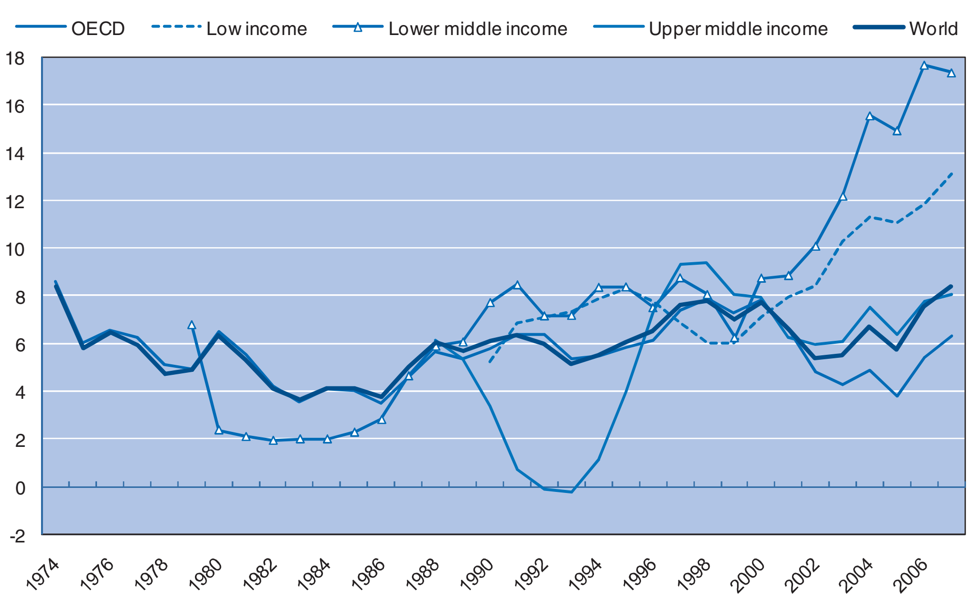
Source: COMTRADE, authors' calculations.

In parallel to the internationalisation of economic activity the distribution of world income and production has been undergoing a major change. A number of lower middle income countries (LMC) and, more recently, upper middle income countries (UMC) have been growing significantly faster than the high income OECD members, increasing their share of the world GDP.[3] Indeed, this trend seems to have intensified over the last few years; the gap in growth rates between the high income OECD and LMC (a grouping that includes such important emerging economies as China, India and Indonesia) widened rather significantly in the mid 1980s and, particularly, since 2002 (Figure 2.4).

Figure2.4. GDP growth by income group
Five-year moving average



Growth of exports of goods and services
Five-year moving average



Source: World Development Indicators (WDI).

The economic rise of many SEM economies coincided with, and indeed depended on, their integration with world markets (OECD, 2008a). The growth rates of exports of goods and services had been generally more in sync across countries in different income groups until the early 2000s, when trade of the low and lower middle income countries (LIC and LMC, respectively) started growing at rates three to four times higher than trade of the high income OECD countries (Figure 2.4). These remarkably higher trade growth rates in the low income and lower middle income grouping have coincided with significantly higher income growth rates of these countries.

While the last three decades have been a period of general opening up to trade and domestic economic reforms, this was much more pronounced for the SEM economies, many of which have recently transformed from centrally planned and/or inward oriented economies to relatively open, market-based ones. OECD (2008a) recently documented the remarkable domestic and trade policy reforms in the six largest SEM economies, Brazil, Russian Federation, India, Indonesia, China and South Africa (BRIICS), that were behind their emergence into the world markets.

The increasing importance of large emerging economies such as the BRIICS on the world stage has been a major factor that contributed to globalisation and adjustment concerns in the OECD countries, mostly because of the large pools of relatively cheap labour they contribute to the world labour force. The BRIICS make up around 49% of the global population, compared to about 18% for OECD countries. In 2007, China and India alone accounted for approximately 37% of the world population (over 1 billion each) and 8% of the value of world output and income at current prices and exchange rates. Hence, integration of these and other SEM economies with the world economy can be seen as a significant shock to world relative factor endowments with ratios of available labour to capital increasing at dramatic rates.

Trade and FDI are the channels through which some the factor differentials are being reduced. For instance, initially the BRIICS tended to export products that have a relatively high labour content but have since moved in to the export of capital intensive goods as well (e.g. Chapters 3 and 5). Similarly, the growth in FDI led to changing patterns of production and that is likely to continue if capital mobility increases, especially with respect to labour mobility, as has been the case in the last decades. Further large and pervasive structural changes can be anticipated for the global economy as income levels continue to increase across emerging economies and per capita production and consumption levels approach those of today's OECD economies, as they are already doing.

Overview of production, employment and consumption developments in OECD countries

Trade, production and consumption are jointly determined which means any technological, behavioural or policy changes that influence one of these categories will also exert an influence over the others. For example, a discovery of a highly demanded natural resource in a country may change the initial specialisation pattern provided the resource can be exported and provided that supply capacity exceeds domestic demand. This section reviews the main broad developments in production, employment, and consumption. Core data used for this purpose come from the OECD Structural Analysis (STAN) database[4] and the International Trade and Balance of Payments (ITBP) database compiled by the OECD and the Eurostat. Trade data used in the next section come from for the United Nations Commodity Trade Statistics Database (COMTRADE).[5]

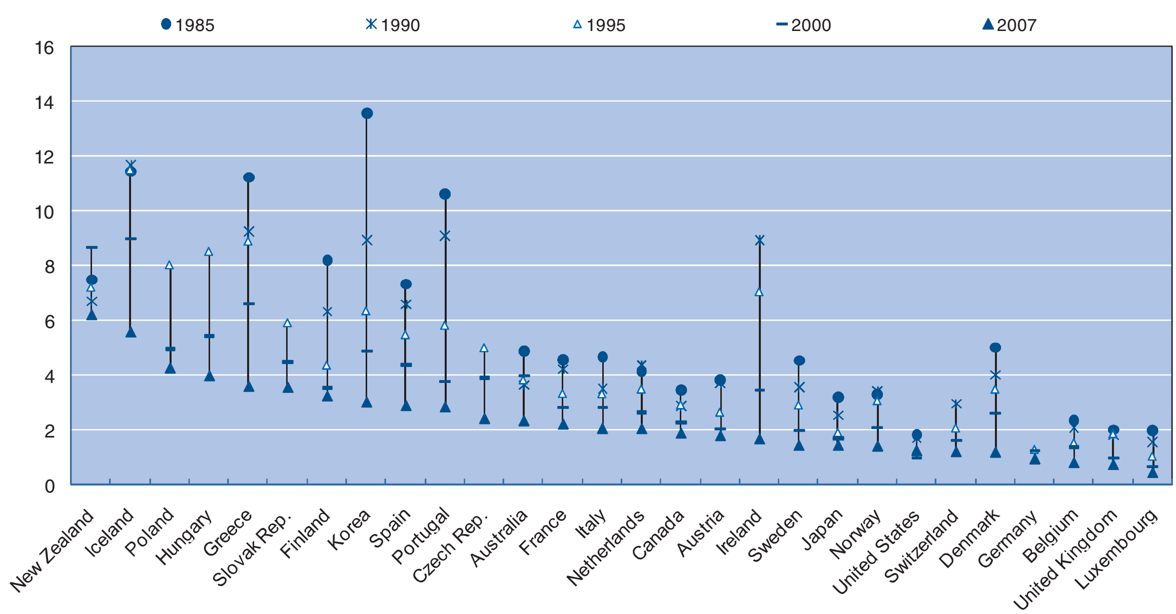
Production and employment

Despite the considerable structural and institutional differences among the individual OECD countries, a relatively uniform picture emerges across this country grouping of a declining contribution of agriculture and, to a lesser extent manufacturing, to value added, and of increasing contribution of the services sector (Figure 2.5).

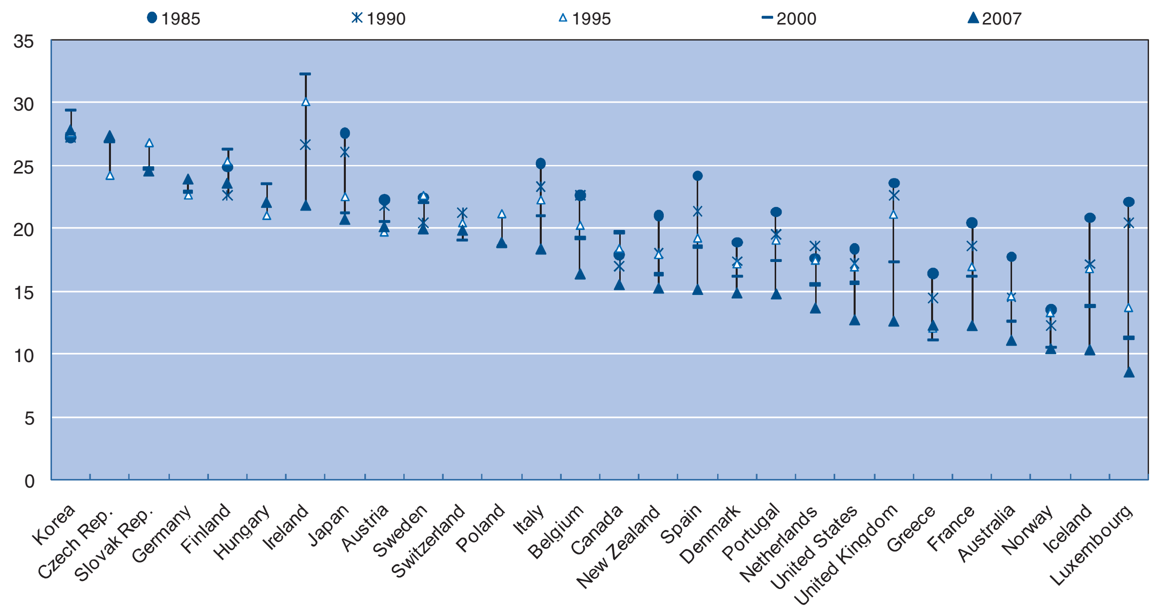
Indeed, in the 1985-2007 period all OECD economies experienced gradual reductions of shares of agriculture in output and value added and some of the most significant reductions occurred in countries with highest initial shares, such as Iceland and Korea. Agricultural output in 1985 for Iceland accounted for 10% of that year's total output. This figure represented the biggest share this sector had in total output across OECD members since the mid-1980s. During the same year, the rest of the OECD countries reported shares below 8% with Korea and New Zealand reporting the second and third biggest shares, respectively. Since then, Iceland and Korea recorded the deepest percentage reductions in the period 1985-2007; bringing the shares of agriculture in output to 5 and 2% in Iceland and Korea. In most other OECD countries shares have declined as well to the level below 4% of total output.

Figure 2.5. Changing structure of the OECD economies

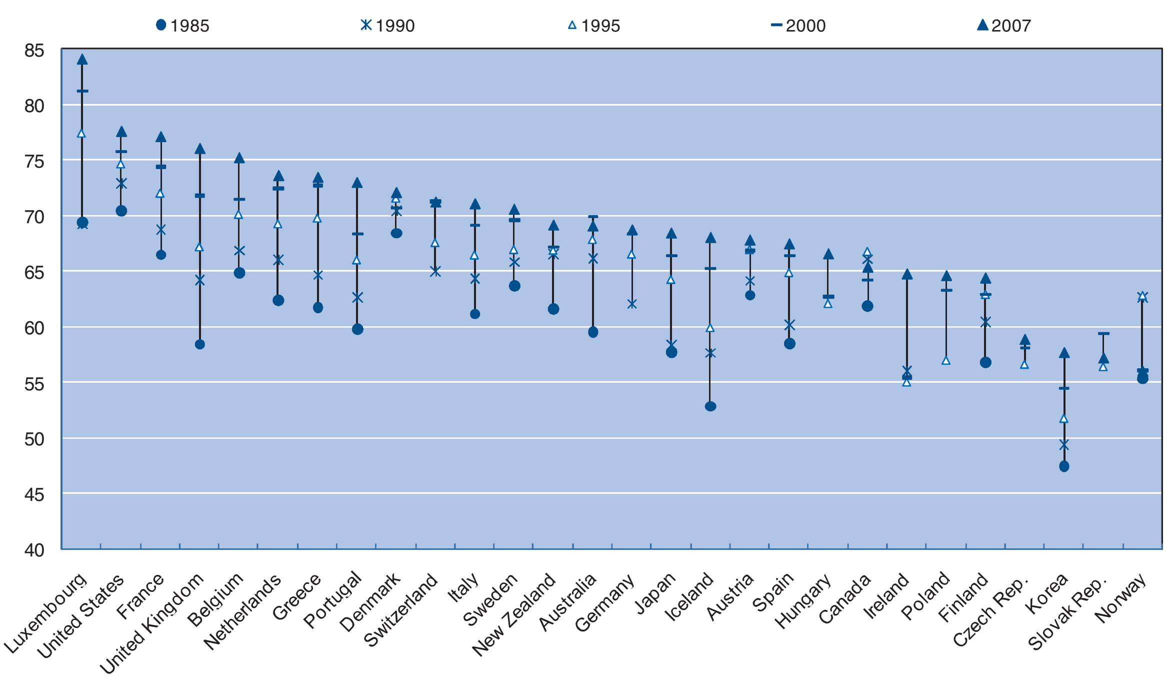
Panel A. Contribution of agriculture to value added in the OECD countries, selected years[a]



Panel B. Contribution of manufacturing to value added in the OECD countries, selected years[a]



Panel C. Contribution of services to value added in the OECD countries, selected years[a]



a) New Zealand, 2004; Canada, 2005; Australia, 2006; Japan, 2006; Poland, 2006; Portugal, 2006; Switzerland, 2006.

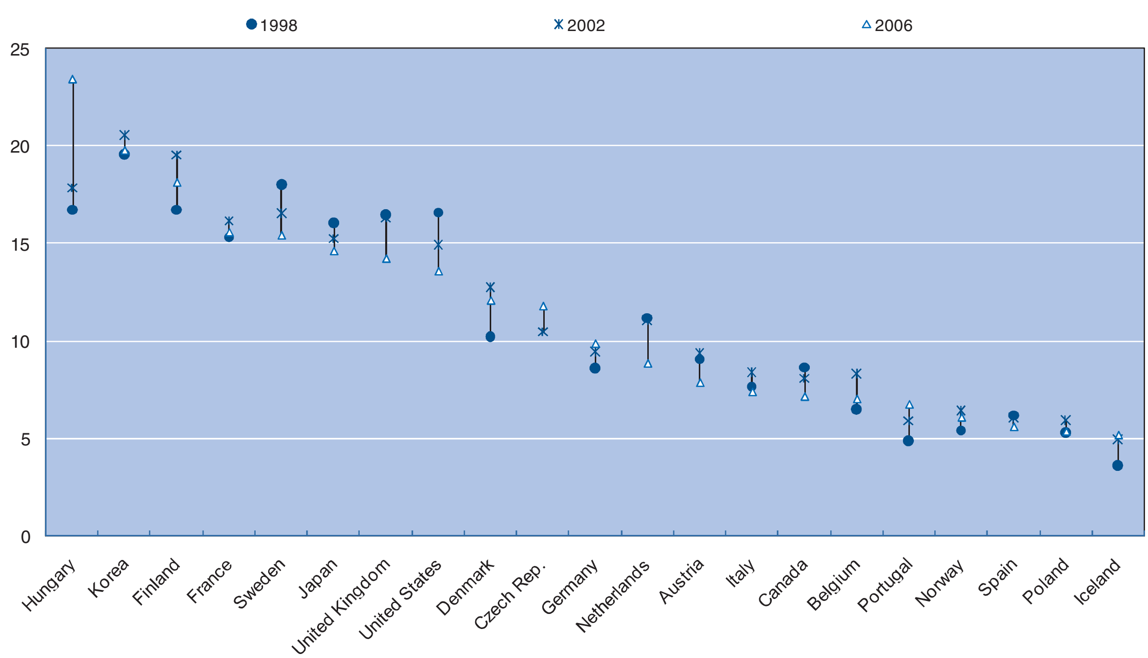
Source: OECD STAN Database.

Manufacturing's shares of output and value added have been generally higher than those of agriculture and developments in manufacturing have been more heterogeneous across OECD membership (Figure 2.5). Manufacturing's shares of output increased in a small number of formerly centrally planned economies (Czech Republic, Slovak Republic, Hungary and Poland) as well as in Germany in the period 1995-2007. Korea was, and still is, the OECD country with the highest shares of manufacturing in output and value added and this sector now represents approximately 50% of Korea's total output and close to 30% of value added. Most other countries recorded manufacturing share reductions with the largest output share reductions in Luxembourg, Portugal and Japan and value added share reductions in Luxembourg, United Kingdom and Ireland. [6]

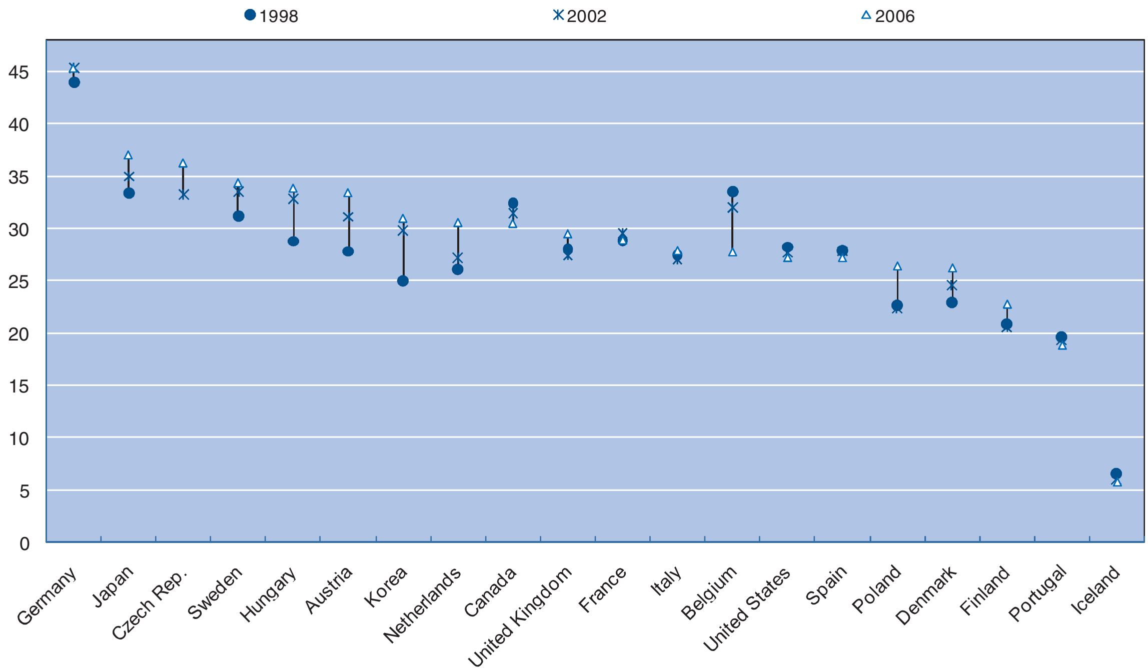
To refine the analysis of specialisation patterns, manufacturing output can be decomposed by technology content.[7] Figure 2.6 indicates that most of the OECD countries have increased their share of medium-high and medium-low technology manufactures. The contribution of low technology manufactures (mostly consisting of food, textiles, leather, footwear, and paper products) has decreased though contribution of medium-low technology sectors (consisting of petroleum products, basic metals and basic metal products, and repairing big capital equipment such as ships and boats) increased across all the OECD countries and of medium-high technology sectors (chemicals, big machinery and equipment mostly used for transport) increased in most OECD countries. The contribution of high technology manufactures (capital equipment of high precision and pharmaceuticals) has been increasing in some OECD countries (Hungary, Czech Republic, and Portugal) and decreasing in others (e.g. United States and United Kingdom). These trends suggest the shrinking shares of manufacturing in total output do not reflect a general withdrawal from manufacturing in the OECD area but rather withdrawal from low technology segments of the manufacturing sector.

Figure 2.6. Contribution to manufacturing output by technology content

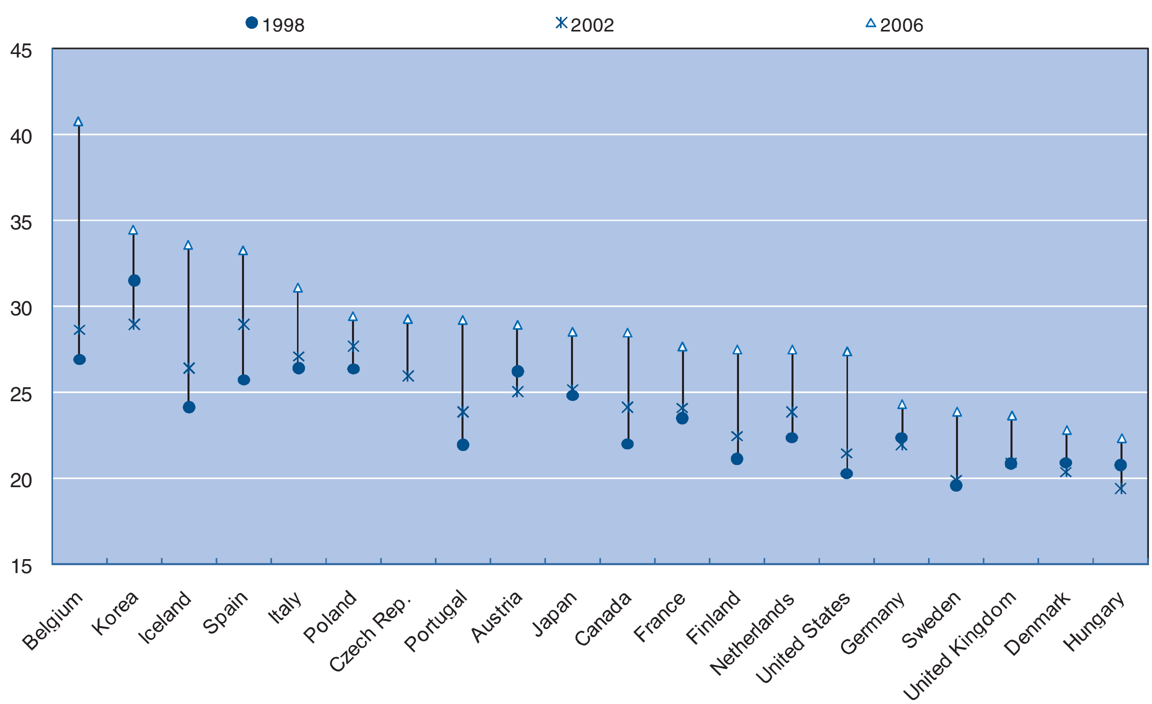
Panel A. High-technology manufacturing



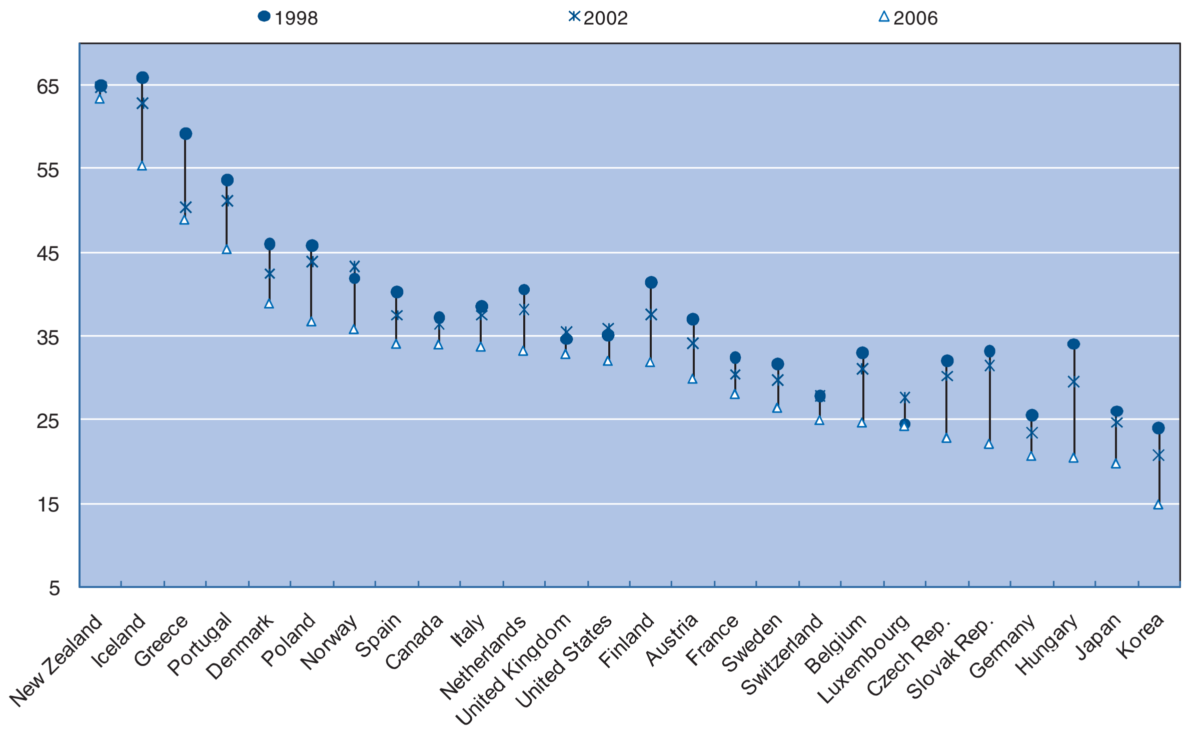
Panel B. Medium-high technology manufacturing



Panel C. Medium-low technology manufacturing



Panel D. Low technology manufacturing



Source: OECD STAN Database.

Throughout the investigated period shares of services in output and value added have been generally higher than those for agriculture and manufacturing though there are some exceptions to this rule, namely in the group comprising Korea and the formerly centrally planned members of the OECD (Poland, Hungary, Czech Republic and Slovak Republic). With the exception of the Czech Republic and the Slovak Republic, the share of services increased in all OECD countries, especially when value added is considered. These figures suggest an unquestionable transformation to a largely services-driven economy for the majority of the OECD countries. In 2007, shares of services in output ranged from just below 40% in Korea (approximately 55% of value added in Norway) to close to 85% of output and value added in Luxembourg.

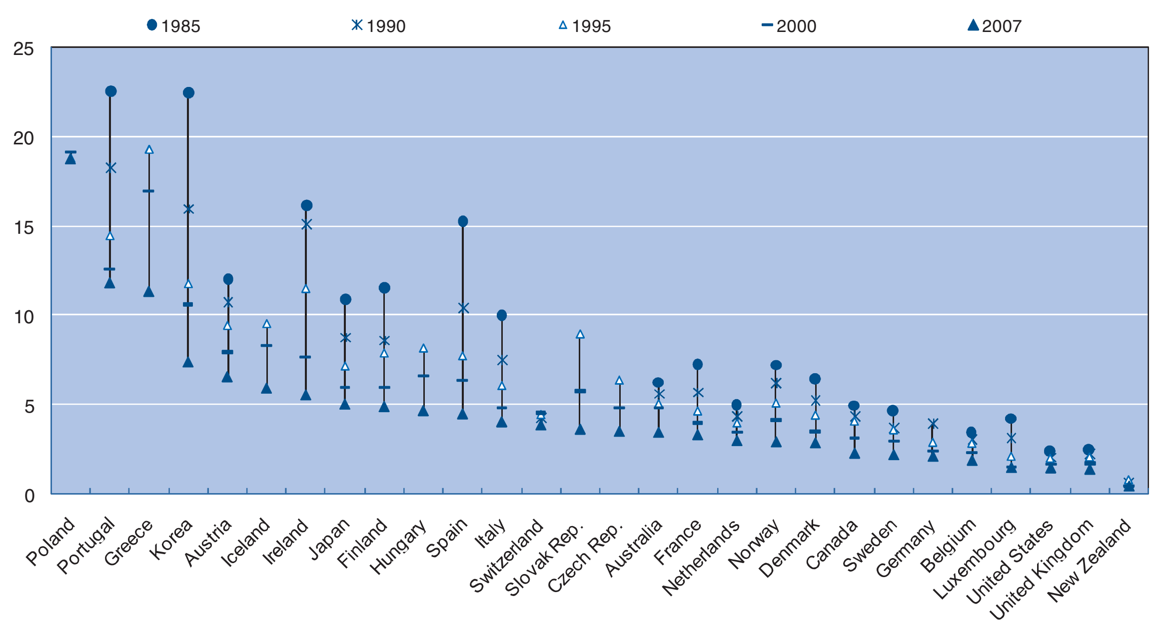
Evolution of employment shares in each of the three broad sectors confirms the transition of the OECD countries into service-oriented economies (Figure 2.7). In fact the shift away from agriculture and manufacturing is even clearer than that suggested by the output and value added data: with almost no exception all OECD economies show an increase in services share of employment and decreasing share of agriculture and manufacturing. The United States, United Kingdom, and the Netherlands display shares of employment in services above 80% for 2007. Portugal and Korea, the two countries with the lowest employment shares of the services sector (of 42 and 45%, respectively) in 1985, show the biggest increases to 60 and 68%, respectively.[8] An inverse pattern is observed for both manufacturing and agriculture as the shares of employment in these two sectors in all OECD economies have seen sharp decreases. Still, while the shares of employment for manufacturing remain in the two digit range in 2007, employment shares of agriculture are below 5%.

Despite a declining trend, the Czech Republic, the Slovak Republic, Hungary and Poland maintain the highest employment shares of manufacturing, ranging from 28% to slightly lower than 20%, across OECD countries. Together with what was observed for output and value added, this suggests a corresponding expansion of services and manufacturing in the Eastern European OECD economies. In addition to the efficiency improvements that arose from the transformation of their domestic economies this could also have been driven by an inflow of foreign manufacturing drawn to the abundance of inexpensive labour, followed by the inflow of supporting services firms from more developed economies, therefore, boosting shares of both services and manufactures.

Labour costs provide a complementary indication of the importance of services in the OECD countries; the sector accounts for the highest, and increasing, share of total labour costs (Figure 2.8). Dynamic productivity growth in the services sector resulted in reallocation of labour towards this sector and triggered a general increase in average labour productivity across all OECD countries. Moreover, increasing employment and labour cost shares of services suggest a constantly mounting influence of the sector on factor and, indirectly, product markets.

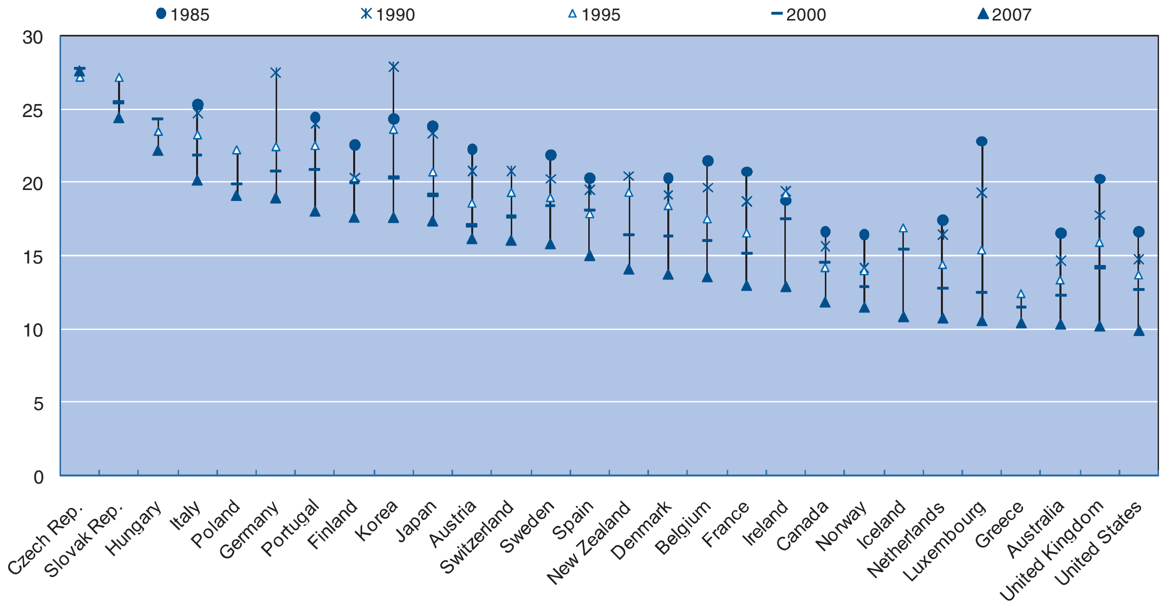
Figure 2.7. Contribution to employment in the OECD countries

Panel A. Agriculture[a]



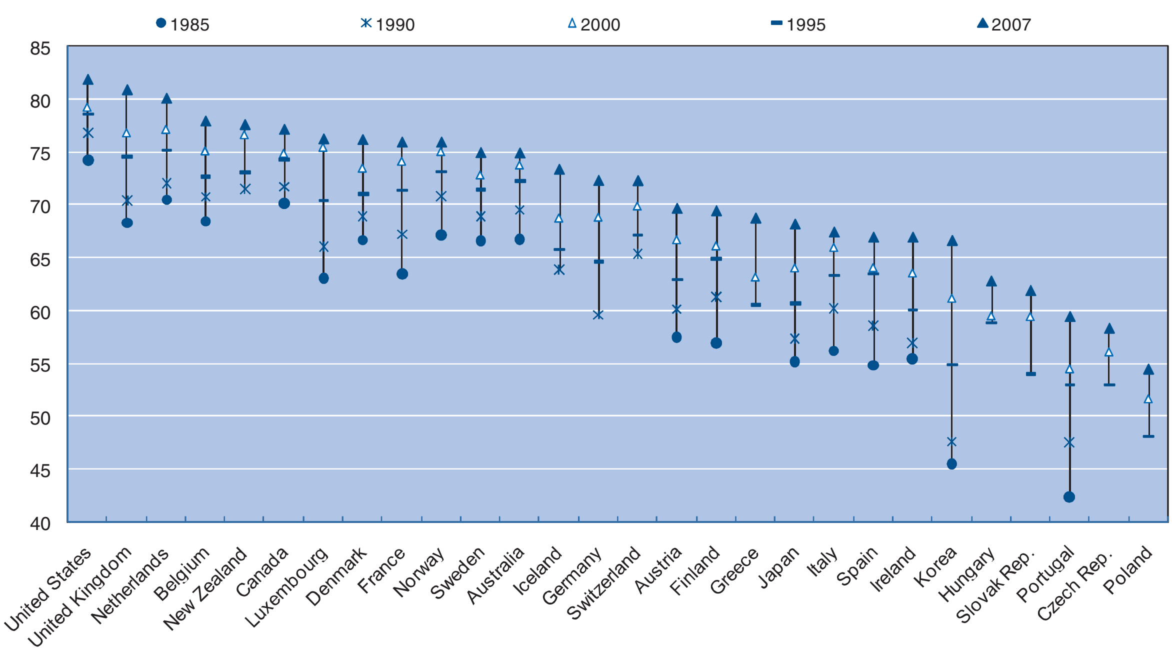
a) Germany, 1991; Switzerland, 1991; Australia, 2006; Portugal, 2006; Poland, 2006.

Panel B. Manufacturing[b]



b) Germany, 1991; Switzerland, 1991; Australia, 2006; France, 2006; Poland, 2006; Portugal, 2006.

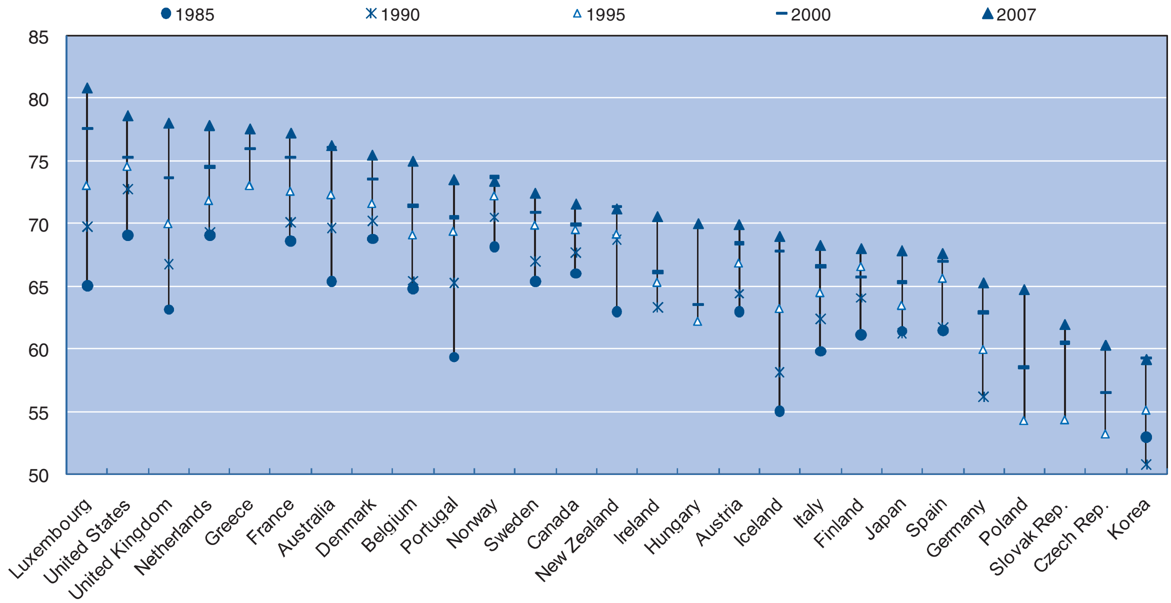
Panel C. Services[c]



c) Germany, 1991; Switzerland, 1991; Australia, 2006; France, 2006; Poland, 2006; Portugal, 2006.

Source: OECD STAN Database.

Figure 2.8. Contribution of services to labour costs in the OECD countries, selected years[a]



a) Germany, 1991; New Zealand, 2004; Japan, 2005; Australia, 2006; France, 2006; Poland, 2006; Portugal, 2006; Sweden, 2006; United Kingdom, 2006.

Source: OECD STAN Database.

Apparent consumption

Production and trade data can be combined to calculate apparent consumption as the difference between the value of production and net exports in a given product or service category. This is a measure of apparent consumption in the sense that we assume any differences between production and net exports (production plus imports minus exports) must be by definition satisfied by domestic consumption.[9] In this way we may get additional hints about the probable causes for the expansion of certain sectors in the OECD economies by considering the demand side of the economy.

In 2006, the shares of agriculture in total apparent consumption were typically below 5% while for most OECD countries the shares of manufacturing were between 20% and 45% (Annex Figure 2.A1). The shares of services range from above 40% in Korea to over 80% in Luxembourg. When we look at the evolution of apparent consumption shares we confirm the expansion of the services sector. The majority of the OECD countries display an increase in the consumption of services. The largest percentage point expansions of consumption of services occurred in Poland, Portugal, and the United Kingdom. Accompanying the increasing services consumption we observe a decrease in the consumption of manufactures and agricultural products.

Can the relative magnitudes of production and consumption changes tell us something about the evolution of broad specialisation patterns in the OECD area and about the role in this process of international trade? One way to look at this is to calculate changes in production and consumption and normalize them with a common denominator, initial production for instance. Proportional changes in consumption can then be compared with propotional changes in production and the difference between them will give us information about the associated proportional change in trade and its direction. Specifically, this kind of analysis allows us to hypothesize about the potential role of international trade in the shift from the production of manufactures to services and how possible imbalances between supply and demand are satisfied by the external sector of the economy.

Therefore, a ratio close to unity would imply demand can be largely satisfied by domestic production. This does not necessarily mean that trade cannot happen but would imply either no trade or an approximately balanced trade in this product category. A ratio smaller than unity would be recorded for a sector which produces a tradeable good and in production of which a country has specialized to the extent that in addition to satisfying its own demand it satisfied demand for this product category in its trading partners. A ratio larger than one would imply consumption demand cannot be satisfied domestically and the country increased its reliance on imports.

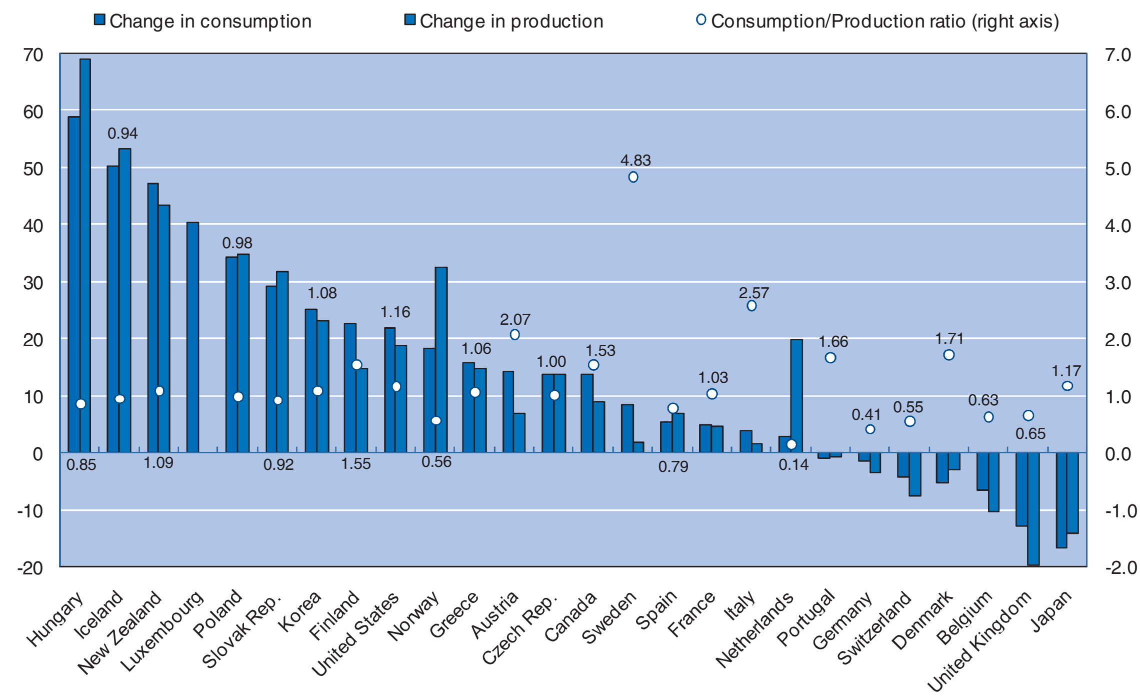
Figure 2.9 shows such ratios for the period 1996-2006 for the broad agriculture, manufacturing and services sectors. Services (Panel C) present a striking case with the calculated ratios close to unity across the OECD membership. This reflects the reality that production and consumption of services in aggregate in the OECD area are largey domestically determined. The developments in the services sector can be contrasted with those in agriculture and manufacturing (Figure 2.9, Panels A and B, respectively). In the case of manufacturing sector we observe more variation of the calculated ratios around unity which suggests higher tradeability of this category as well as a more heterogenous pattern of concentration of ouput in the manufacturing sector across the OECD members. On the one side of the spectrum would be the Czech Republic, Hungary, Korea, and the Slovak Republic which seem to have increased their specialisation in the manufacturing sector through international trade in the investigated period. On the other side of the spectrum are Greece and Iceland which seem to have partially satisfied the increasing demand through net imports of manufactures.

In the agricultural sector the variation of ratios across OECD members is even larger. This would confirm the hypothesis of a higher potential for specialization and the comparative advantage in the agricultural sector to be driven by natural conditions such as geography and climate. Moreover, there is also more variation in the proportional changes in production and consumption suggesting a major international adjustment of supply and demand. In Japan and the United Kingdom, for example, we observe both consumption and production decreases. The magnitude of the production drop is larger than the consumption one in the United Kingdom while we observe the reverse in Japan. These two situations imply active external markets in both countries to accommodate for changes in demand and supply.

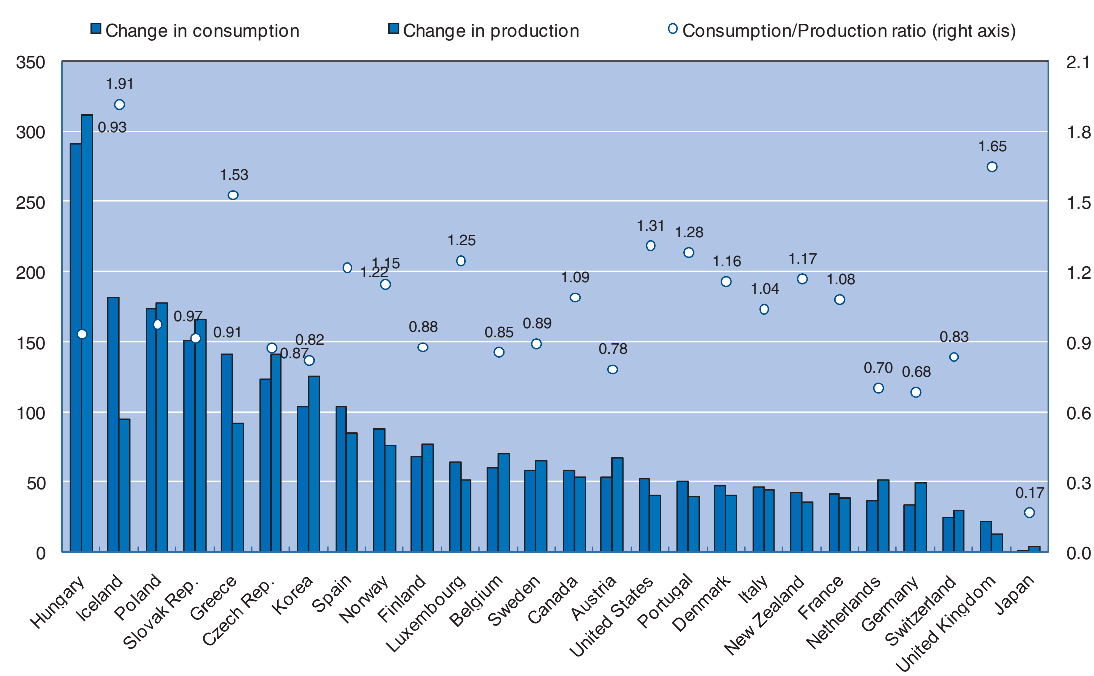
Overall, the analysis of changes in production and apparent consumption tells us that services are not as actively traded as manufactures and agricultural products and that their expansion in the last decades in the OECD has been a largely domestically driven process. Agriculture and manufacturing are clearly different in this sense and developments in these sectors are more tightly related to developments in international markets.

Figure 2.9. Relationship between changes in production and consumption, 1996-2006

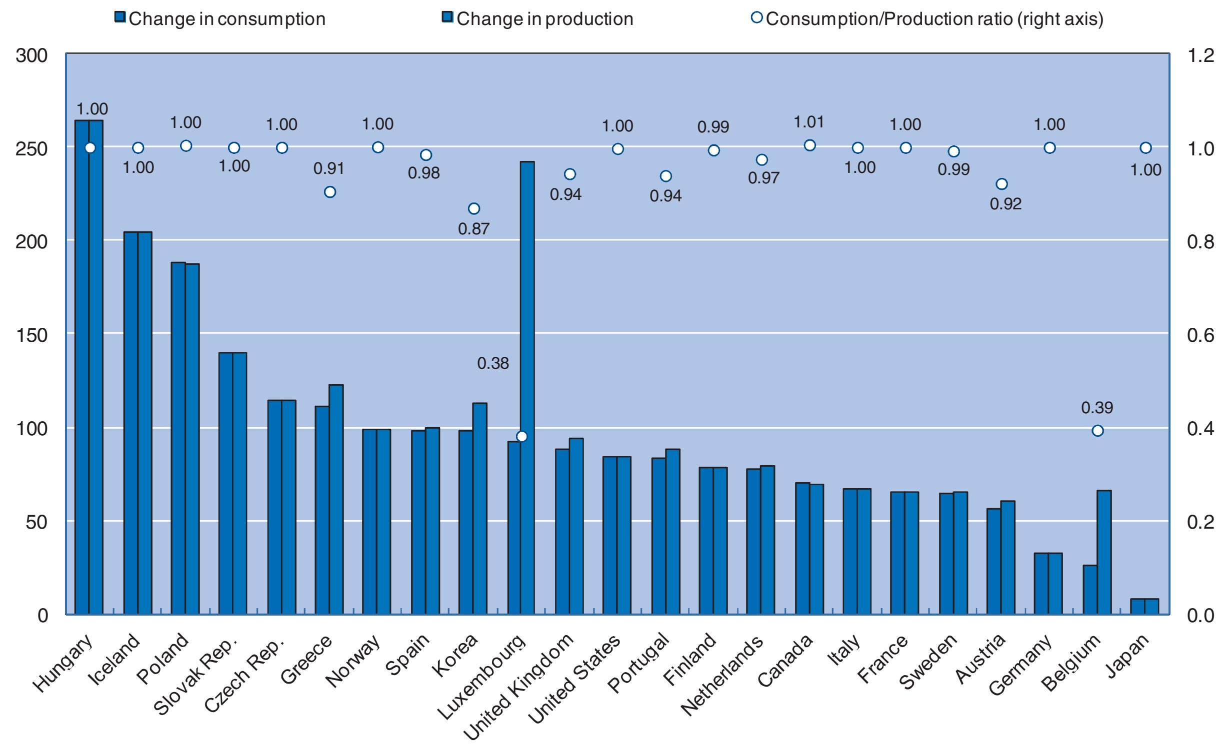
Panel A. Agriculture



Panel B. Manufacturing



Panel C. Services



Source: OECD STAN Database and ITBP.

Selected trade developments

Market shares

World market shares--the most basic trade performance indicators—broadly indicate that while the OECD area lost shares in the world market for goods (from 85% of world exports in 1990 to approximately 60% in 2008) the same has not been the case for what one can measure as trade of services;[10] OECD's share remained constant at approximately 62% of the world exports. The SEM economies grouping has more than doubled its share in the world goods exports from 13% in 1990 to approximately 35% in 2008, and in services from approximately 15% in 1990 to 26% in 2008. These broad figures and their dissection that follows below suggest a number of developments. First, they confirm the status of the emerging market grouping, in both merchandise trade and services. Second, they suggest that the OECD countries' shares have been gradually reduced in the area of merchandise trade, while in services this has not been so much the case, even though the potential of the EM in this area is clearly visible.

Figures 2.10 and 2.11 present goods and services' market developments in the period 1990-2007 for individual OECD and SEM economies. They reveal the following tendency: the eight largest OECD goods exporters (Germany, United States, Japan, France, Italy, Netherlands, United Kingdom and Canada) have been losing goods market shares in the period 1990-2007, while a number of medium size and smaller OECD exporters have been gaining market shares (Korea, Mexico, Spain, Poland, Czech Republic, Ireland, Turkey, Hungary and Slovak Republic). Noticeably, some of these dynamic OECD exporters belong to the group of less well off OECD members that share many characteristics which held them back economically in the past (such as central planning or inward looking policies) with the SEM grouping.

Most economies in the SEM grouping have gained goods market share since 1990. China's performance has been exceptional as it increased its goods market share five-fold since 1990; it accounted in 2007 for close to 9% of the world goods market. This compares to the remaining larger SEM exporters that typically do not account for more than 2.5% of the world market. The individual shares of the vast majority of SEM economies are smaller than 1% but some of these economies such as Kazakhstan, Estonia, Chile and India have been increasing their shares at distinguishably high rates.

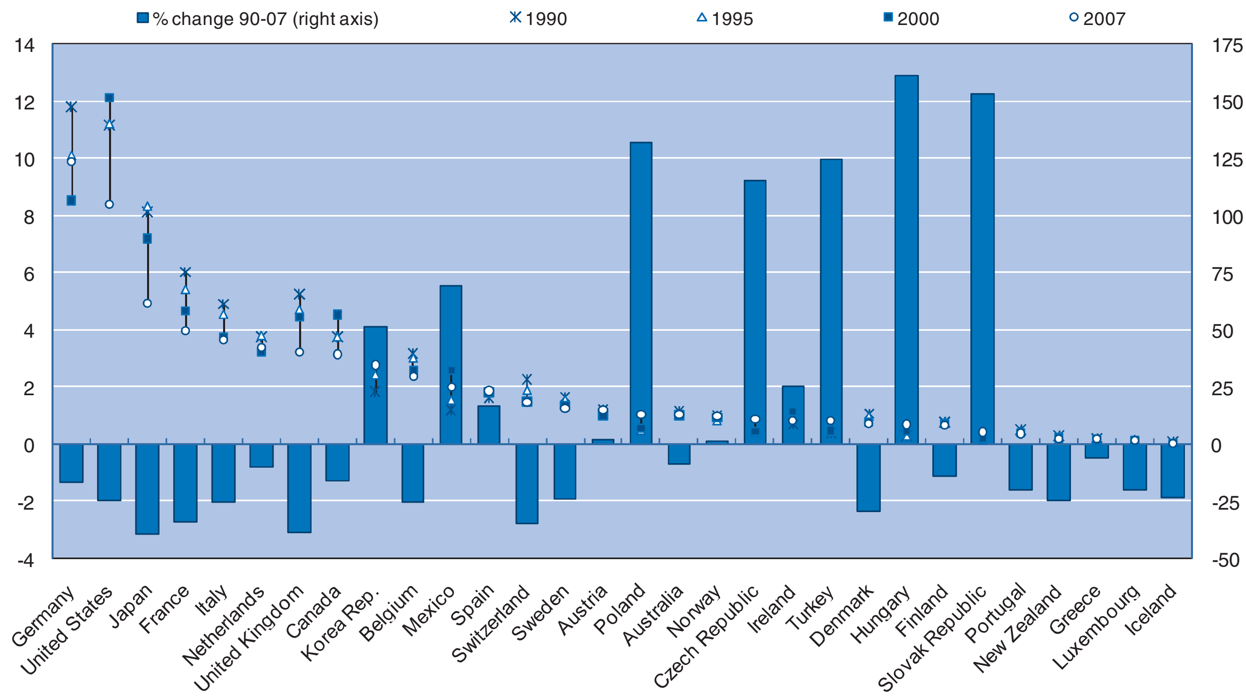
The distribution of world services market shares appears more concentrated in 2007 than that of goods markets (Figure 2.11). The US share of 14.4% is double that of the second largest service exporter, the United Kingdom (8.2%). Yet, the dynamic picture is more diversified as compared to goods; some large OECD exporters have been gaining market shares (e.g. United Kingdom, Spain) as have been a number of smaller ones (e.g. Ireland, Luxembourg, Korea, Greece, Poland, Hungary). Ireland has increased its share by more than five-fold over the period 1990-2007 while Luxembourg and Poland more than doubled their shares. This suggests that gains in services market shares have been distributed more evenly across the OECD membership.

Figure 2.11 reveals also that competition in services markets from SEM economies has been increasing as vigorously as in the goods markets. Indeed, the four largest SEM services exporters (China, India, Hong Kong, China and Singapore) now together have more than 10% of the world market share and the Chinese and Indian shares approximately quadrupled in the considered period. In fact, China's share in the world services exports has been growing faster, and is now higher, than that of India. Several smaller SEM exporters have also increased their market shares.

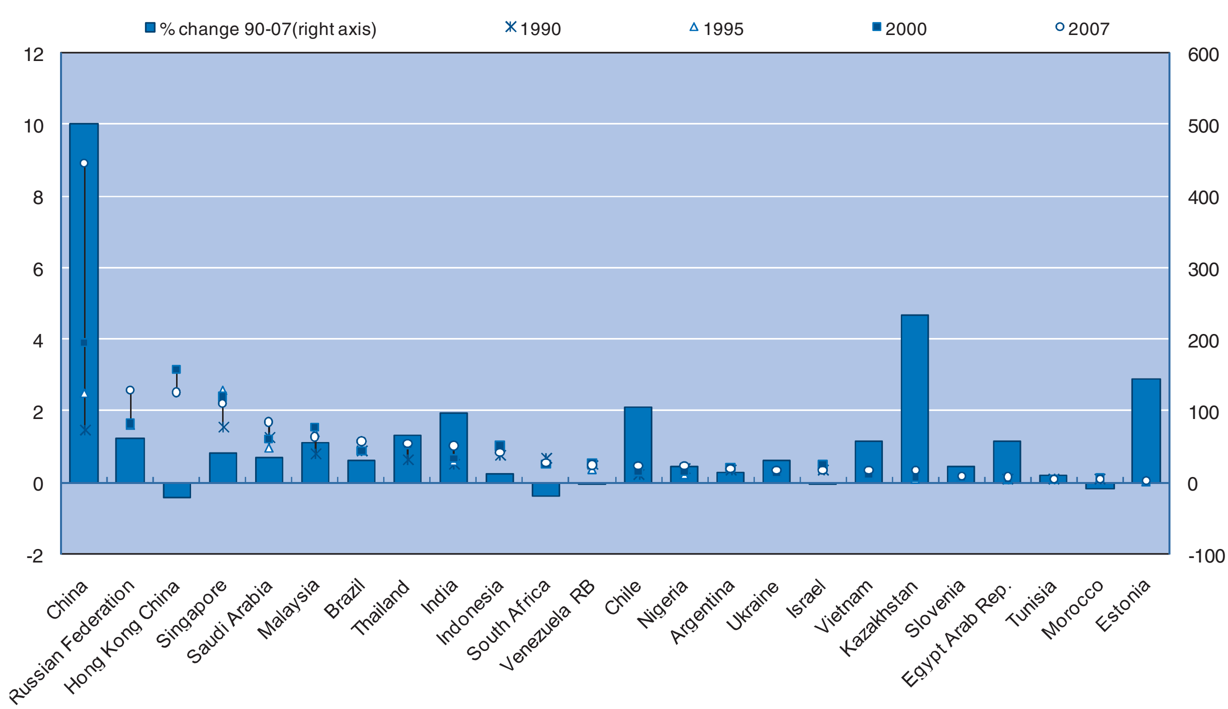
Normalised trade balances (Figure 2.12) are considered as a fundamental indicator of sectoral competitiveness.[11] For the goods trade the normalised balances have polarised across OECD members in the period 1990-2007; countries with initially positive balances tended to improve their positions over the analysed period (e.g. Norway, Ireland, Germany) while in countries with initial negative balances (e.g. United States, United Kingdom) tended to deteriorate. In 2007, 15 OECD members had negative goods balances while only seven had negative services balances. A slight tendency for convergence of services balances (reduction of large positive and negative balances) over time could also be observed. Interestingly, countries with the largest positive balances in goods tended to have the largest negative balances in services suggesting a certain pattern of goods/services specialisation even within the OECD membership.

Figure 2.10. Shares in world goods exports, 1990-2007

Panel A. OECD countries



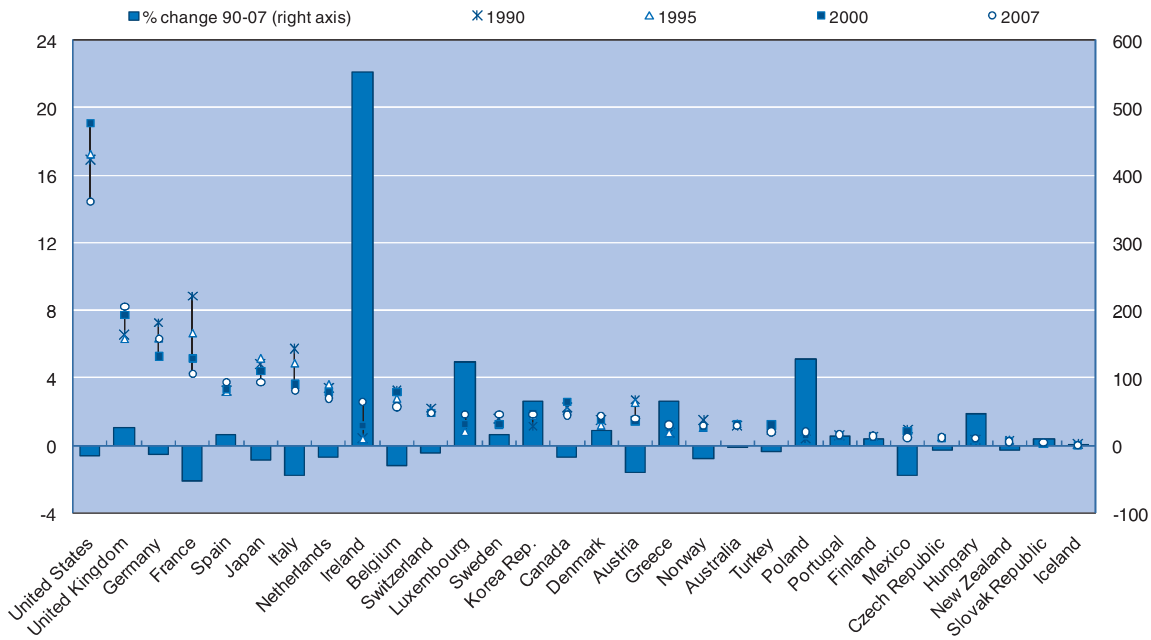
Panel B. Selected emerging market countries



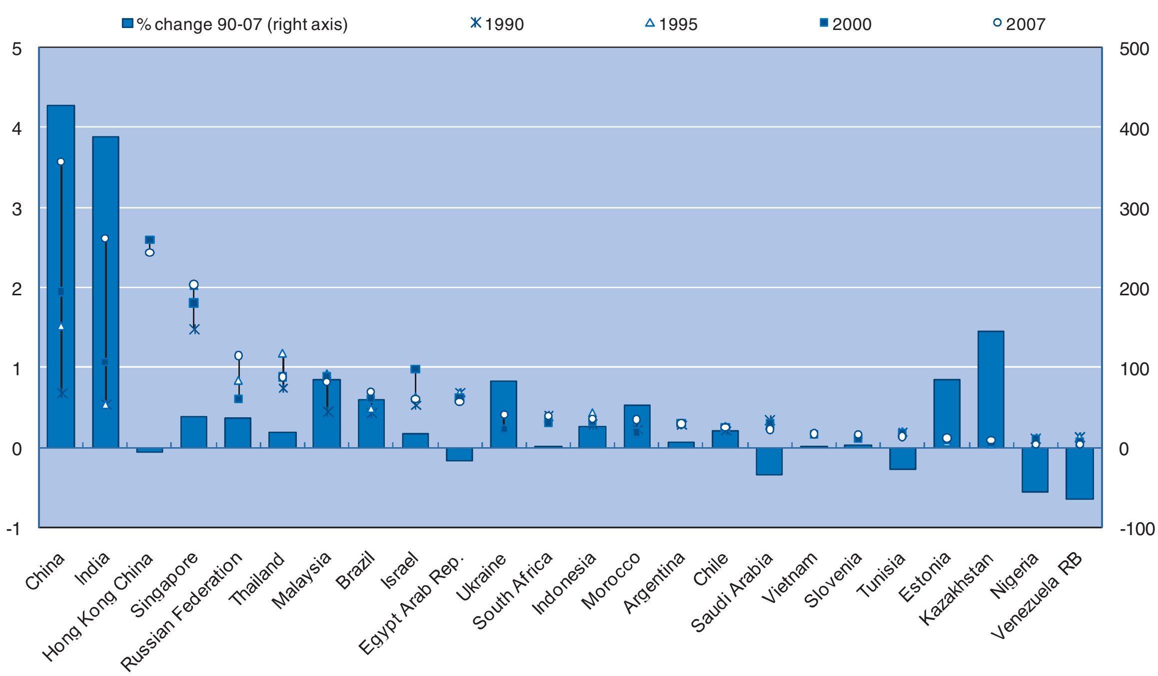
Source: Balance of Payment Statistics (IMF BOP) and World Development Indicators (WDI).

Figure 2.11. Shares in world services exports

Panel A. OECD countries

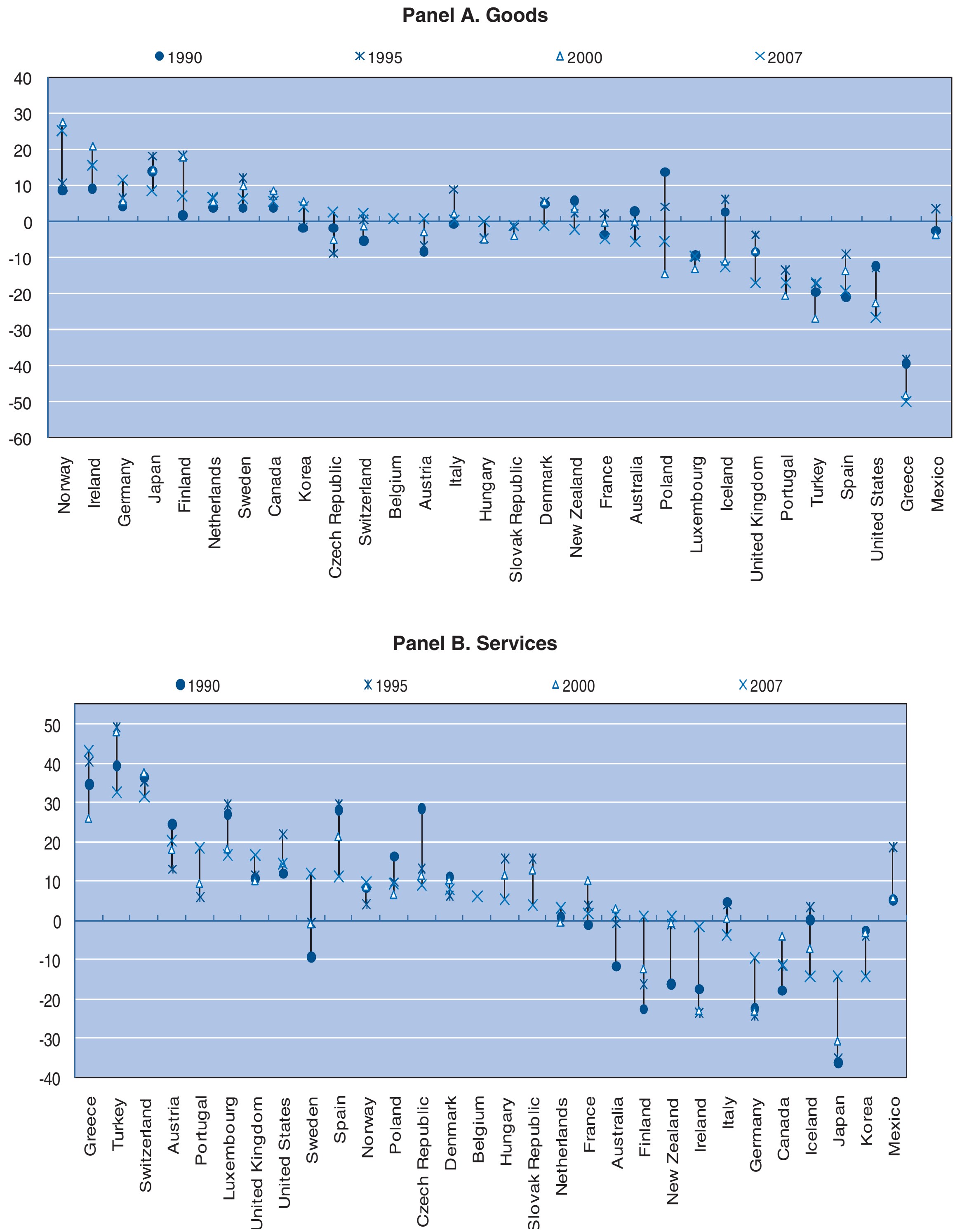


Panel B. Selected emerging market countries



Source: Balance of Payment Statistics (IMF BOP) and World Development Indicators (WDI).

Figure 2.12. Normalised trade balances



Source: OECD Macro Trade Indicators database.

Composition of trade flows by broad product categories

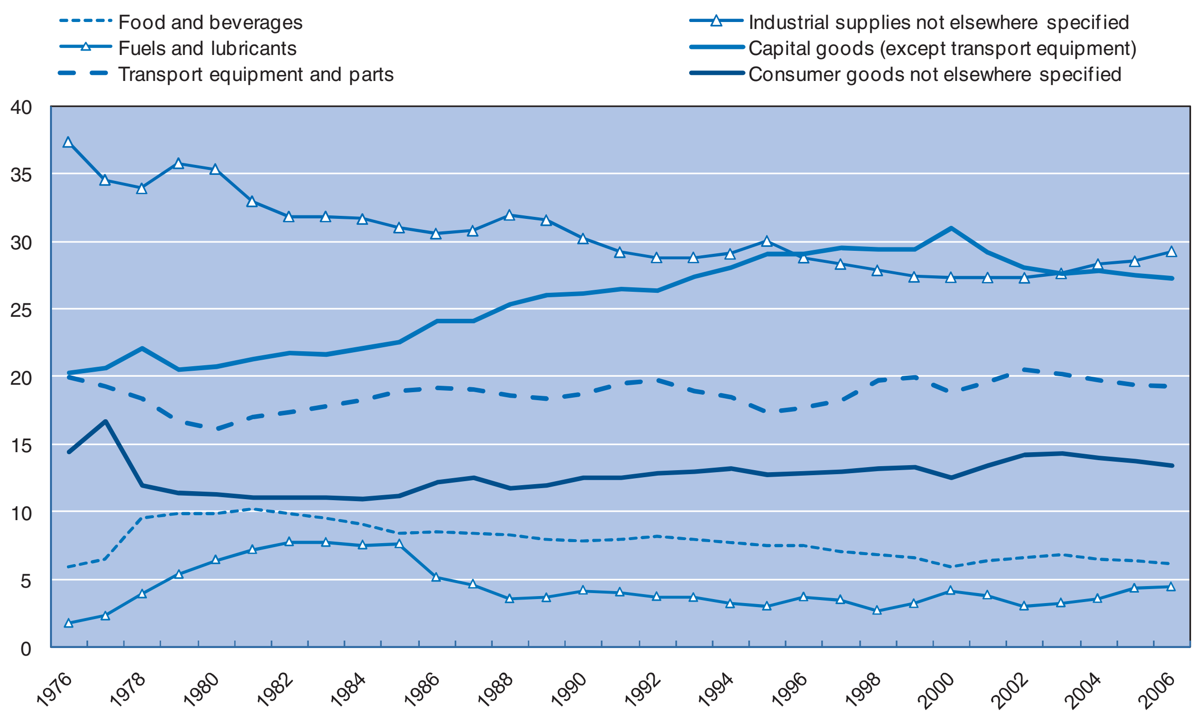
Integration of the SEM economies with the world merchandise markets has been accompanied by significant changes in OECD and SEM economies' export structures. Before we look at individual product categories it is worth considering the UN classification of products into Broad Economic Categories (BEC) that group products according to their ultimate use. For the OECD area fuels and lubricants have always been and continue to be the smallest category of exported products (Figure 2.13, Panel A). Yet, this is also the category that has increased proportionally the most since mid 1970s. In contrast, industrial supplies were the largest category and accounted for more than 35% of the OECD exports in the mid-1970s and this is also the category that grew the slowest throughout the 1976-2006 period and now accounts for 29% of exports. Capital goods have recorded growth rates second only to fuels and lubricants and their share climbed from around 20% to 30% in the period. The share of food and beverages exports also increased considerably.

These changes in the composition of OECD exports can be contrasted with those of exports of low and middle income countries (LMC) grouping that contains most members of our SEM grouping (Figure 2.13, Panel B). In LMC fuels and lubricants were practically the only major category of exports and accounted for more than 70% of this group's exports in mid-1970s. At the same time, fuels and lubricants exports were the slowest growing category and now account for less than 20% of LMCs' exports. Industrial supplies have become the most important export category (from below 20% of exports in the mid-1970s to 26% in 2006). Remarkably, capital goods and, albeit to a smaller extent, consumer goods emerged from almost non-existing export categories to, respectively, the third and the fourth largest categories with just above 21% and 16% of value of total LMC exports.

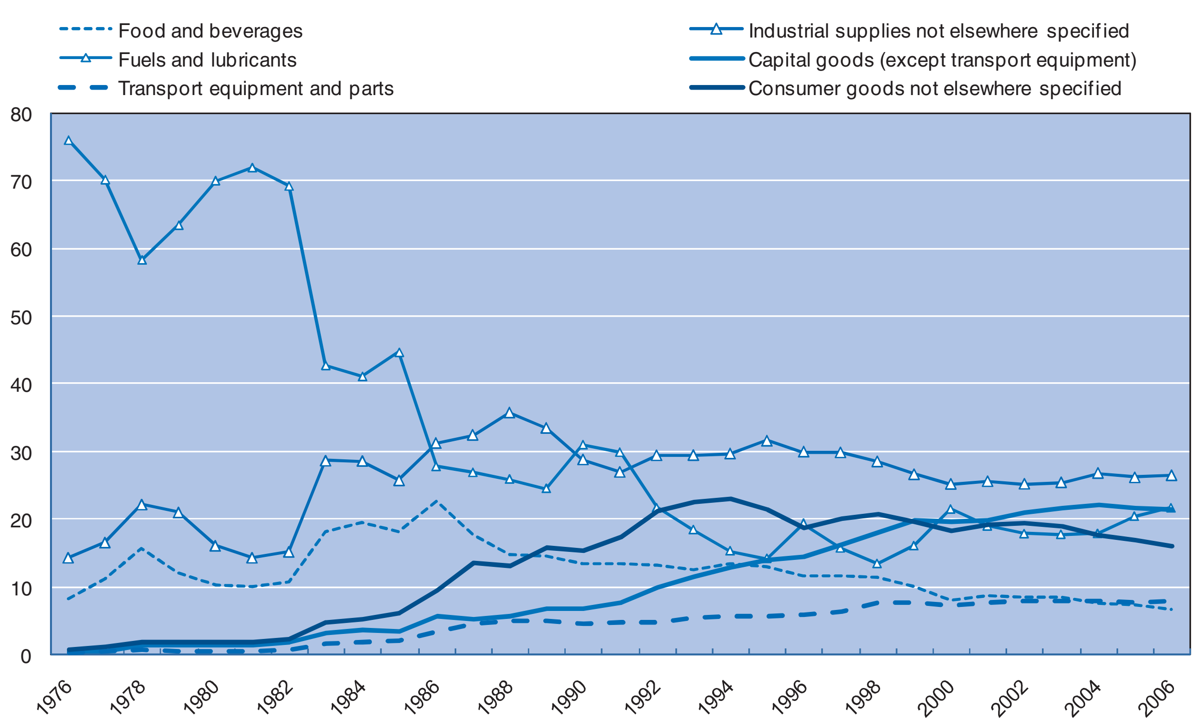
These trends suggest three main features of international trade over the last three decades. First, while international trade has been, and continues to be, an important channel for sourcing of industrial supplies, OECD countries' share in this type of exports have decreased (from 85% in 1976 to 67% in 2007) while it increased for the LMC (from 15 to 30%).[12] Second, and perhaps more importantly, international trade has increasingly been dominated by international exchange of capital goods, i.e. goods that serve as a basis for production of other goods or services. Even more so than for industrial supplies, trade in this type of products transformed from largely one-way type (exports from the OECD to LMC) to more of a two way trade; in mid-1970s the OECD countries accounted for close to 100% of exports while in 2006 this share was below 70%. Third, exports of consumption goods by LMC have grown dramatically and the share of the OECD in the world market for consumption goods fell from 97% in mid-1970s to 62% in 2006. This category also accounts now for a smaller share of total OECD exports in contrast to LMC exports where this category is much more prominent than three decades ago.

Figure 2.13. Exports by product use

Panel A. OECD grouping, shares



Panel B. Lower middle income countries, shares



Source: UN ComTrade Database.

Similarity of trade specialisation patterns

Revealed comparative advantage indices help in determining whether a country is relatively specialised in a given industry's exports, regardless of whether this is a result of different endowments base or a result of policy (Chapters 1 and 3). If the value of the index is greater than one it can be inferred the country is relatively specialised in this industry's exports; the share of this industry within the total exports of goods of this country is more than the corresponding share for the world. The RCA indices are reported for goods for the years 1990 and 2007 in Annex Tables 2.A1 and 2.A2 and for the years 1995-2007 for services in Annex Tables 2.A3 and 2.A4. They reveal that OECD members are quite a heterogeneous group in terms of their export specialisation, especially in goods.

A more sophisticated analysis of RCA indices in the manufacturing sector is presented in Chapter 3 of this volume and here we are merely seeking to use this approach to broadly assess the similarity of specialisation patterns. In particular, we are interested which countries have become more similar to each other in terms of composition of their exports. Annex Figure 2.A2 combines the data on RCA indices of OECD countries with equivalent data for the SEM grouping producing bilateral rank correlation coefficients of RCA indices calculated at the 2-digit HS level for the period 1988-2008. These coefficients indicate the degree to which the ranking of industries, according to their revealed comparative advantage indices, of one country is correlated with the ranking of another country. Annex Figure 2.A2 presents these correlations and their evolution in time for each of the countries in the G7 and the BRIICS (Brazil, Russia, India, Indonesia, China and South Africa) countries.

The specialisation pattern of the United States is positively correlated with all other G7 members with a tendency for this correlation to increase over time. There is also a clear negative correlation with China, India and Indonesia. Germany's export specialisation pattern is highly correlated with that of the United Kingdom, France and Japan while it is correlated negatively with those of China, Indonesia or India. However, Germany's correlation with China and Indonesia has increased over time. As already mentioned Japan's specialisation pattern is similar to those of Germany and the United Kingdom (and to a lesser extent with the United States) while it is correlated negatively with those of India, Brazil or Indonesia. Correlation of Japan with China has changed significantly from a moderately negative one at the end of 1980s to a positive one in 2000s. This is clearly a sign of the transformation of the Chinese manufacturing and the role Japanese and other OECD MNCs played in it.

China's specialisation pattern is correlated positively only with four of the G7-BRIICS countries: Italy, Japan, Indonesia and India. This correlation has been increasing particularly in cases of Italy and Japan, and to somewhat lesser extent Indonesia. It has been, however, consistently decreasing in the case of India, signifying, perhaps the different economic development paths these two labour-abundant countries have adopted.[13] China's correlations with other countries are negative and deepening which approximately means they are trading in increasingly different products, apart from the above mentioned case of Germany. India's correlation coefficients generally decreased with respect to all its larger competitors with the exception of the United Kingdom where there has been a tendency for the correlation of the specialisation patterns to increase. Brazil's correlation coefficients suggest positive, and increasing, correlation with a number of important agricultural and natural resources exporters such as Russia, South Africa, Canada, India, Indonesia and the United States. Its correlation coefficient with China has decreased from a neutral position to a moderately negative one.

This initial analysis of the evolution of revealed comparative advantage indices confirms the rise of the SEM economies but also points to the marked differences in the OECD and SEM groupings. At the same time, certain OECD and SEM countries are similar in their endowments or development strategies and specialisation patterns and there are indications suggesting that a more direct commercial competition may be emerging in some of these cases.

Conclusions

This chapter outlined broad trends in trade, production and consumption and underscored that economic activity is today more international than at any time in the past. Sourcing of foreign intermediate goods has intensified and capital goods are the fastest growing category of world trade, and processed industrial supplies are currently the largest traded category. Simultaneously, the distribution of world income and production has been undergoing major changes. A number of lower middle income countries (LMC) and, more recently, upper middle income countries (UMC) have been growing substantially faster than the high income OECD members. Some earlier evidence suggests that in a vast majority of cases the rising incomes coincided with the opening up of these countries to trade.

Despite the considerable structural and institutional differences among the individual OECD countries, a relatively uniform picture emerges across this country grouping of a declining contribution of agriculture and, to a lesser extent manufacturing, to value added, output and employment, and of increasing contribution of the services sector At the same time, the former two sectors have become more integrated across international markets, with larger shares of consumption satisfied from foreign sources. Services, at least to the extent we are currently able to measure them, are not as actively traded as manufactures and agricultural products and that their expansion in the last decades in the OECD has been a largely domestically driven process.

Notes

1. Przemyslaw Kowalski, Trade Policy Analyst, Trade and Agriculture Directorate, OECD, and Ricardo H. Cavazos Cepeda, Director General, Estudios Económicas Comisión Federal para la Protección Contra Riesgos Sanitarios Mexico. The authors would like to thank Clarisse Legendre for excellent statistical assistance and the OECD Working Party of the Trade Committee for providing direction and comments. Material presented in this chapter benefited from comments and guidance of the Working Party of the OECD Trade Committee, participants to the OECD Global Forum on Trade in Chengdu, China as well as an internal OECD workshop with participation of representatives from Brazil, China, India, Indonesia and South Africa.
2. For more on vertical trade, see Miroudot and Ragoussis (2009).
3. World Bank income groups were used and are defined as follows. High income OECD includes high income OECD members where high-income economies are those in which 2007 GNI per capita was USD 11 456 or more. Upper-middle-income economies are those in which 2007 GNI per capita was between USD 3 706 and USD 11 455. Lower-middle-income economies are those in which 2007 GNI per capita was between USD 936 and USD 3 705. Low-income economies are those in which 2007 GNI per capita was USD 935 or less.
4. This dataset is based on the Revision 3 of the International Standard Industrial Classification (ISIC).
5. There are several important caveats related to the data used that have to be considered. First, the data coverage of the STAN and ITBP datasets is not uniform across variables and countries. Second, since the STAN dataset does not include data on trade in services, this data, covering cross-border trade and consumption abroad, are drawn from an alternative source--the ITBP. Third, combining data from different sources and classification systems creates concordance problems at lower levels of sector aggregation and, hence, the apparent consumption estimates here are calculated for broad sector categories of agriculture, manufacturing, and services. Finally, the time coverage of production data is more restricted as compared to trade data.
6. The countries which display a decrease in their manufacturing share are: Italy, Austria, Spain, Portugal, Canada, Netherlands, France, New Zealand, Denmark, United States, Greece, Norway, United Kingdom, Iceland, and Luxembourg.
7. The classification used is that used in the OECD STAN database.
8. Other countries that show marked increases of their shares of employment in services starting from 1985 until to 2007 are: Spain, Japan, Ireland, Italy, Finland, Austria, France, and Luxembourg.
9. This definition of consumption also encompasses domestic investment purchases. As pointed out by Deardorff (2010) the intention of the concept of apparent consumption is not to distinguish different uses for a good within the country, but only to infer the total that is used there for any purpose.
10. This analysis is based on the IMF Balance of Payments (BOP) statistics that cover modes 1 and 2 of services trade, cross-border trade and consumption abroad. Provision of services connected to foreign presence is thus not covered.

11. The normalised trade balance is measured as the trade balance divided by the sum of exports and imports.
12. For more on vertical trade, see Miroudot and Ragoussis (2009).
13. OECD (2008a) documented the greater emphasis on manufacturing in China and on services in India.

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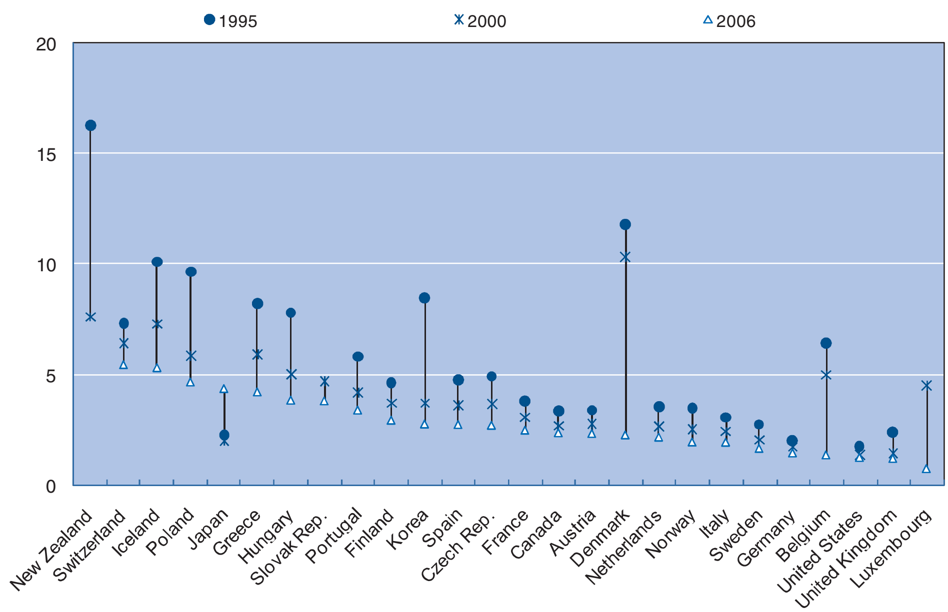
Annex 2.A.

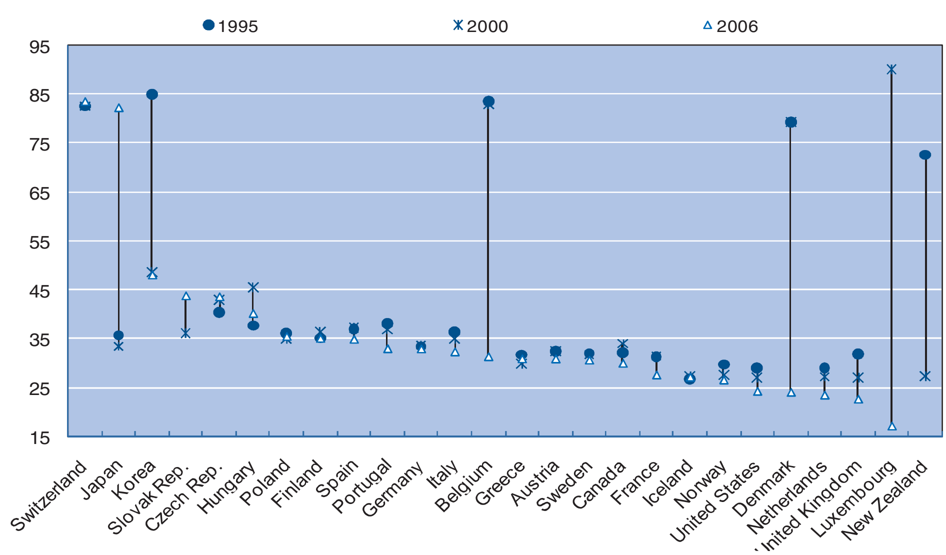
Figures

Annex Figure 2.A1. Apparent consumption

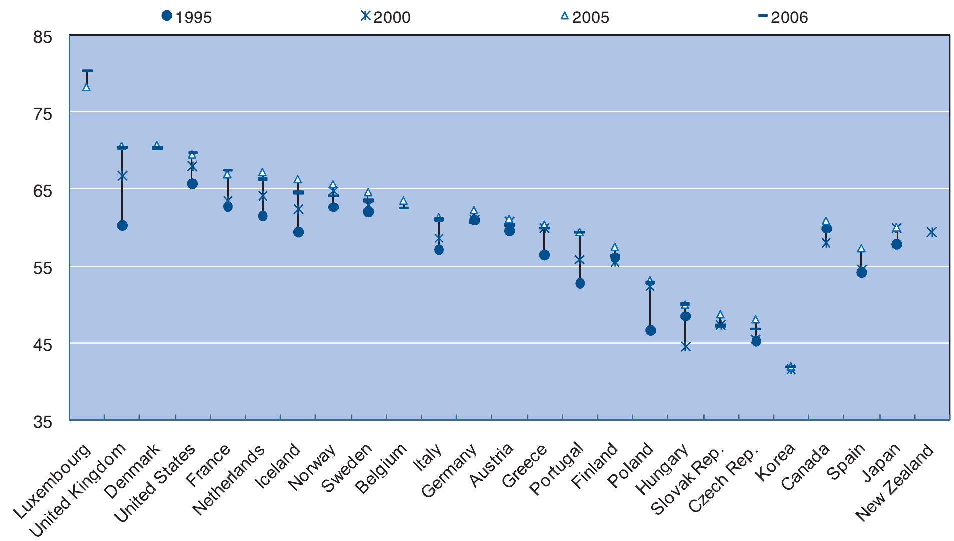
Panel A. Agricultural products as percentage of total consumption, selected years



Panel B. Manufactures as percentage of total consumption, selected years



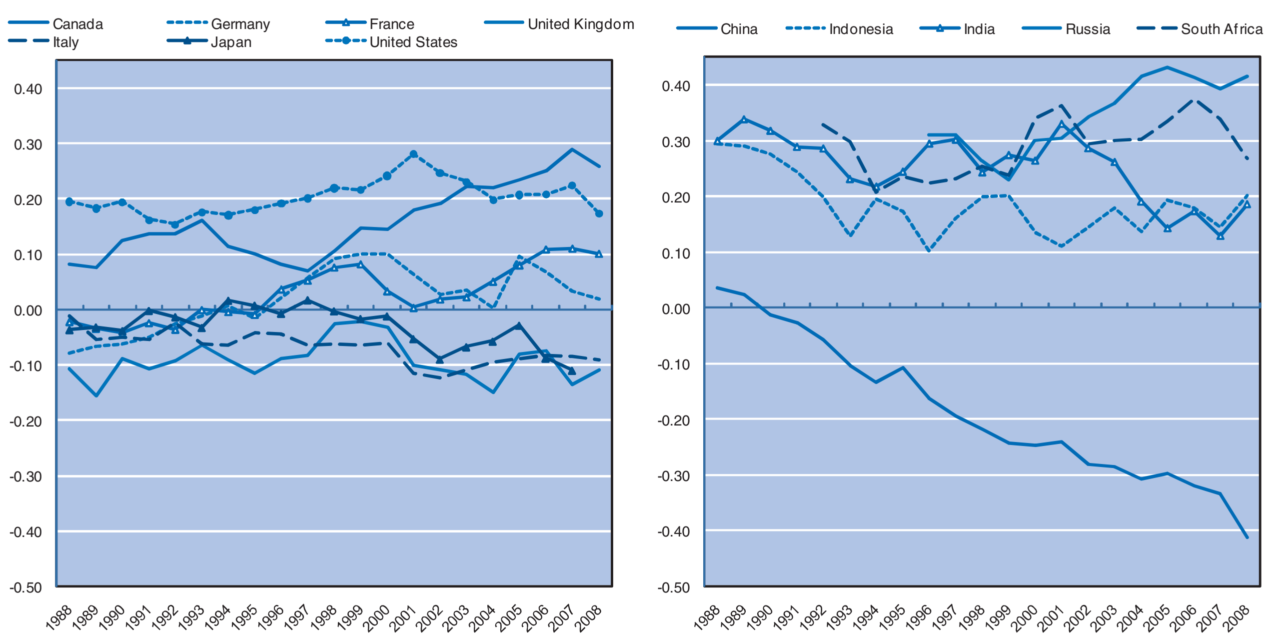
Panel C. Services as percentage of total consumption, selected years



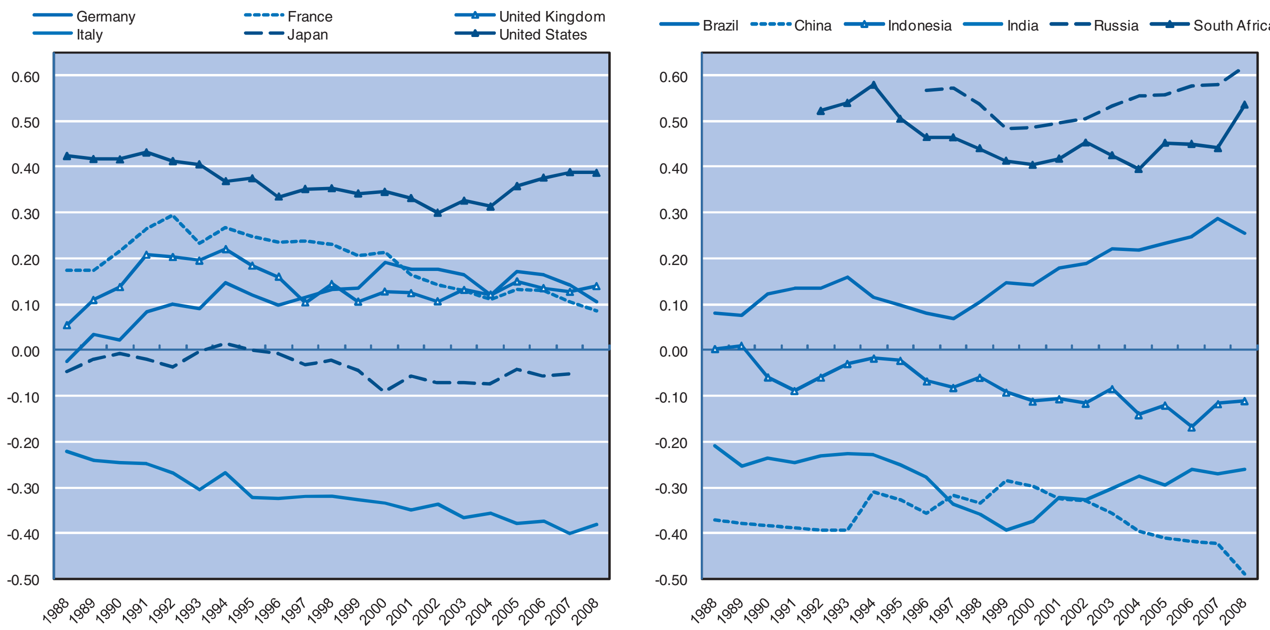
Source: OECD STAN Database.

Annex Figure 2.A2. Rank correlation coefficient of RCA indices in manufacturing

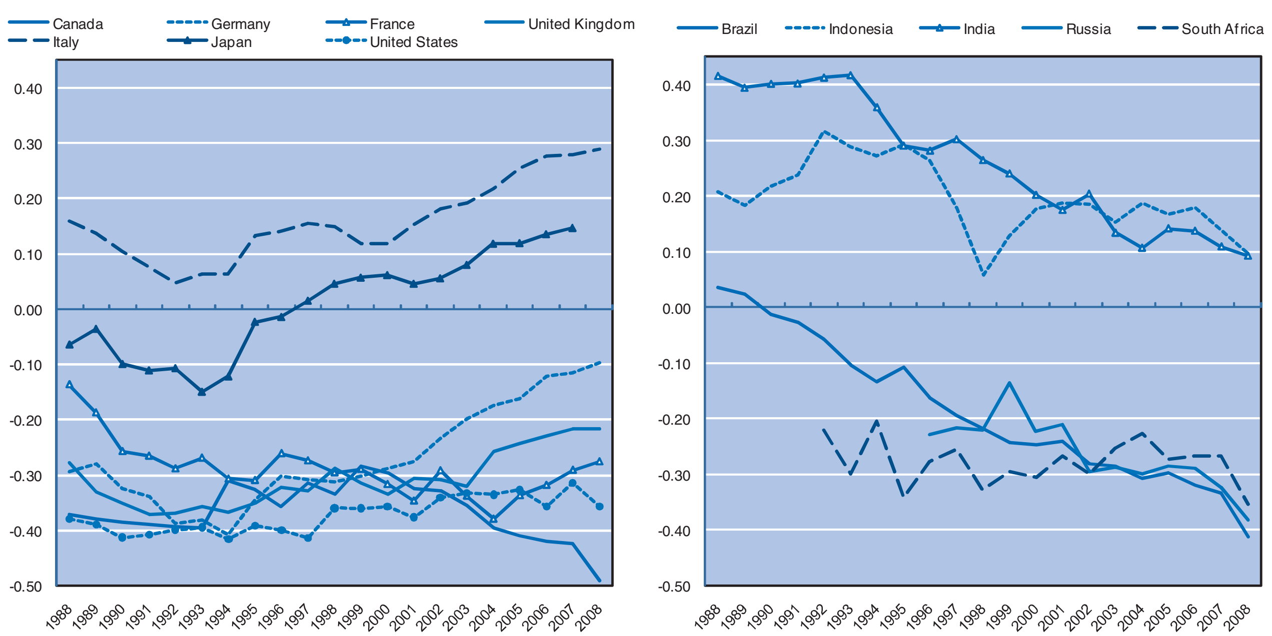
Panel A. Brazil



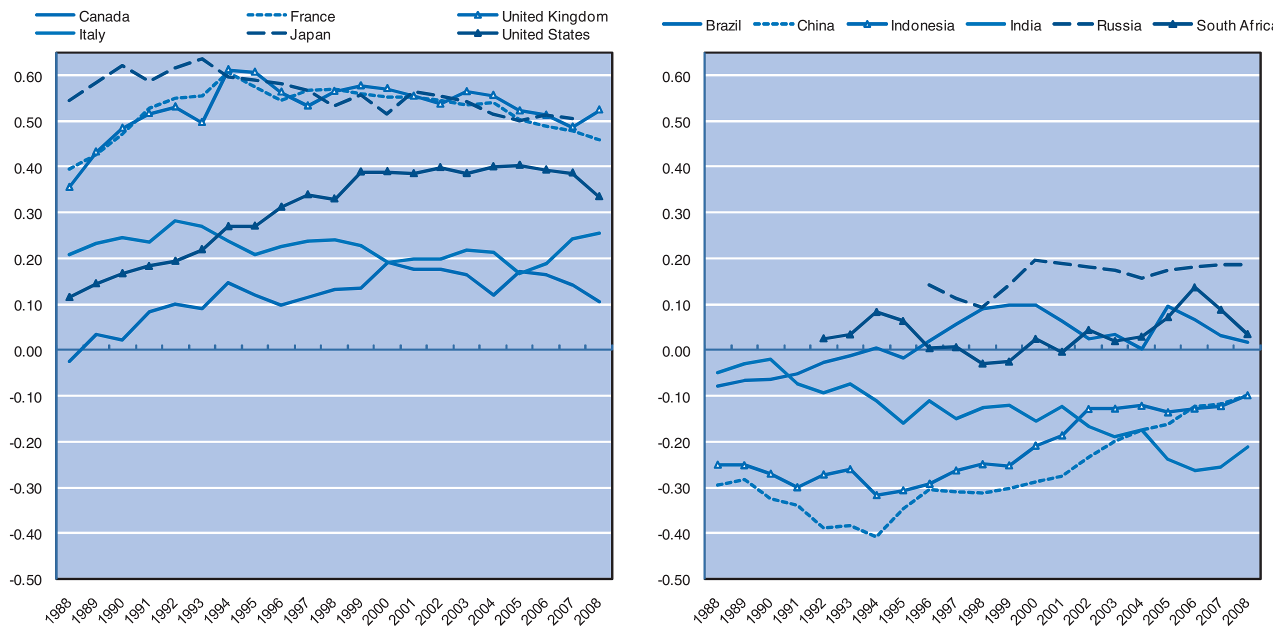
Panel B. Canada



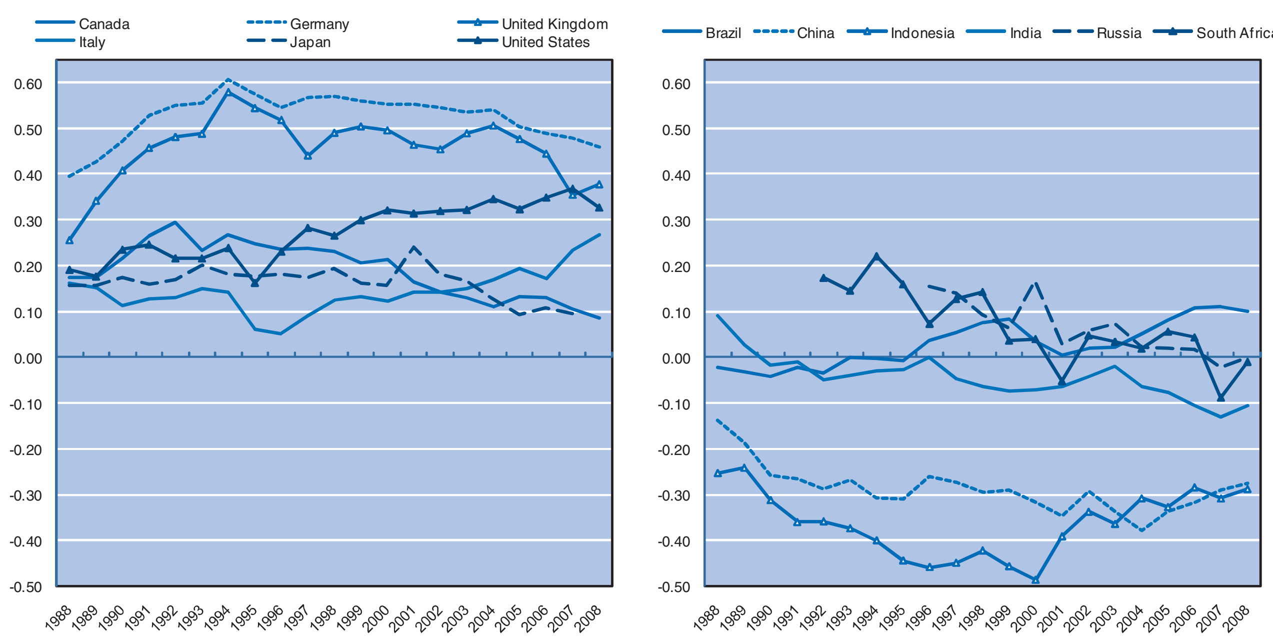
Panel C. China



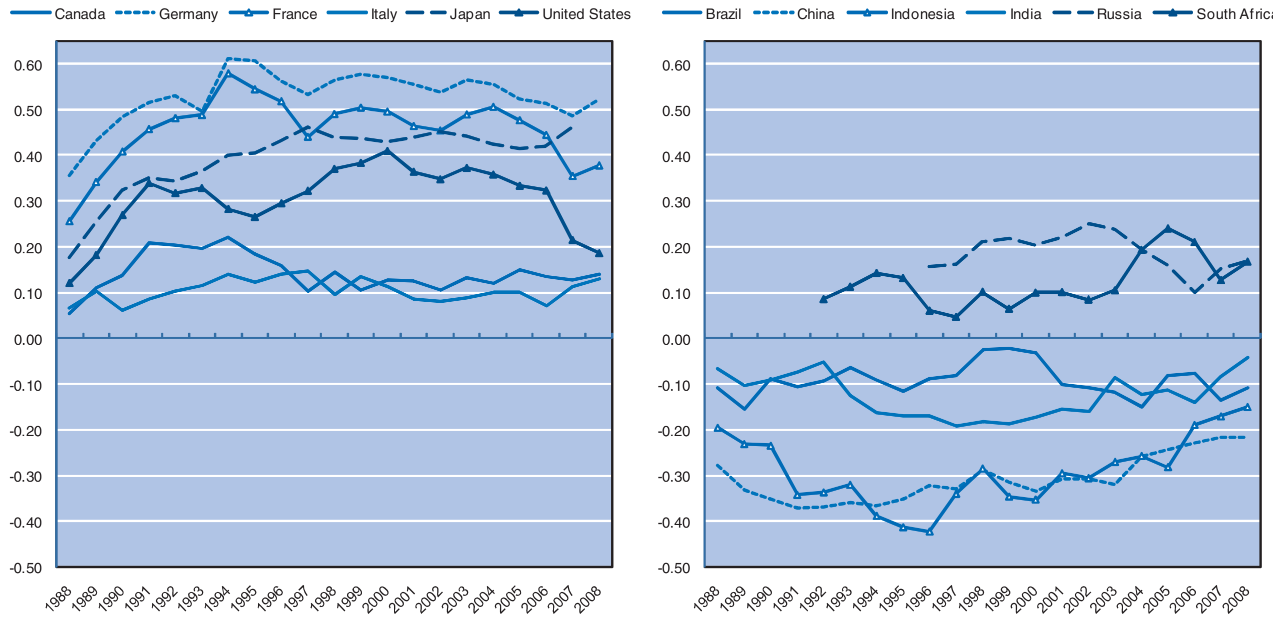
Panel D. Germany



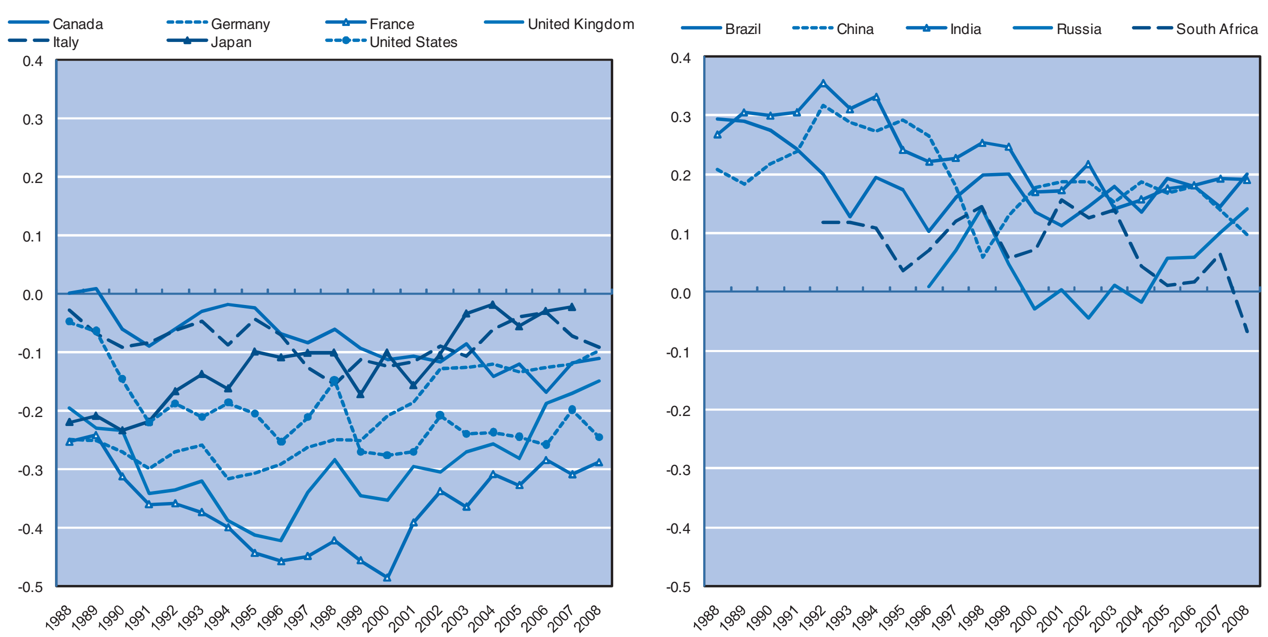
Panel E. France



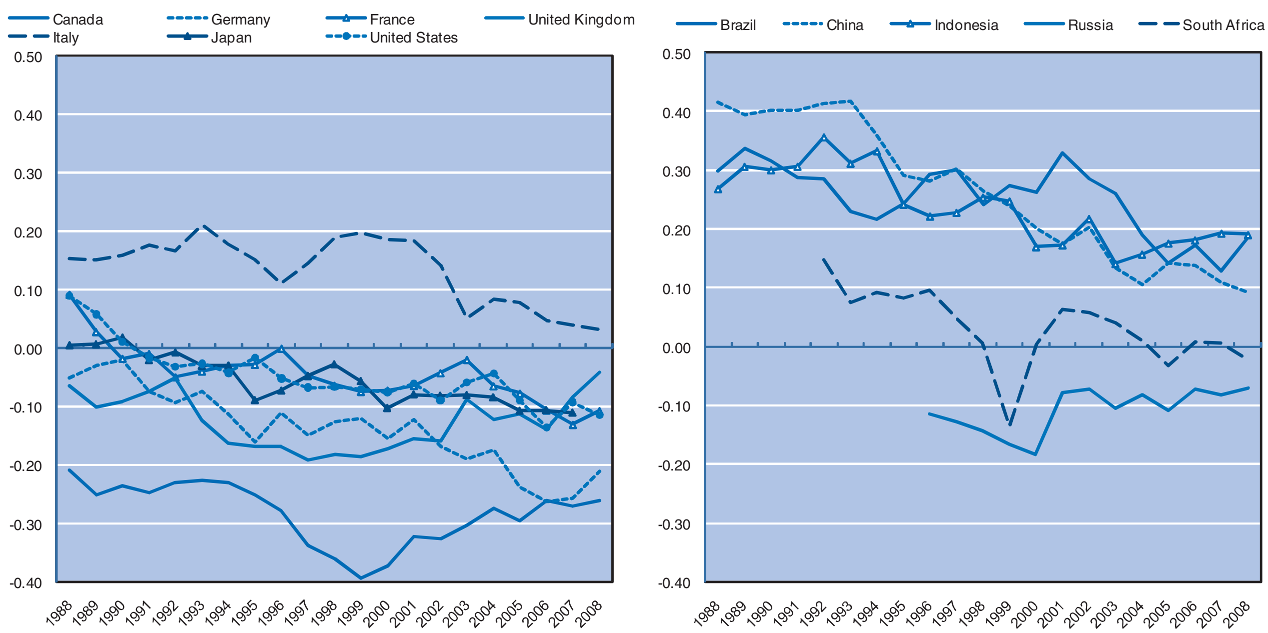
Panel F. United Kingdom



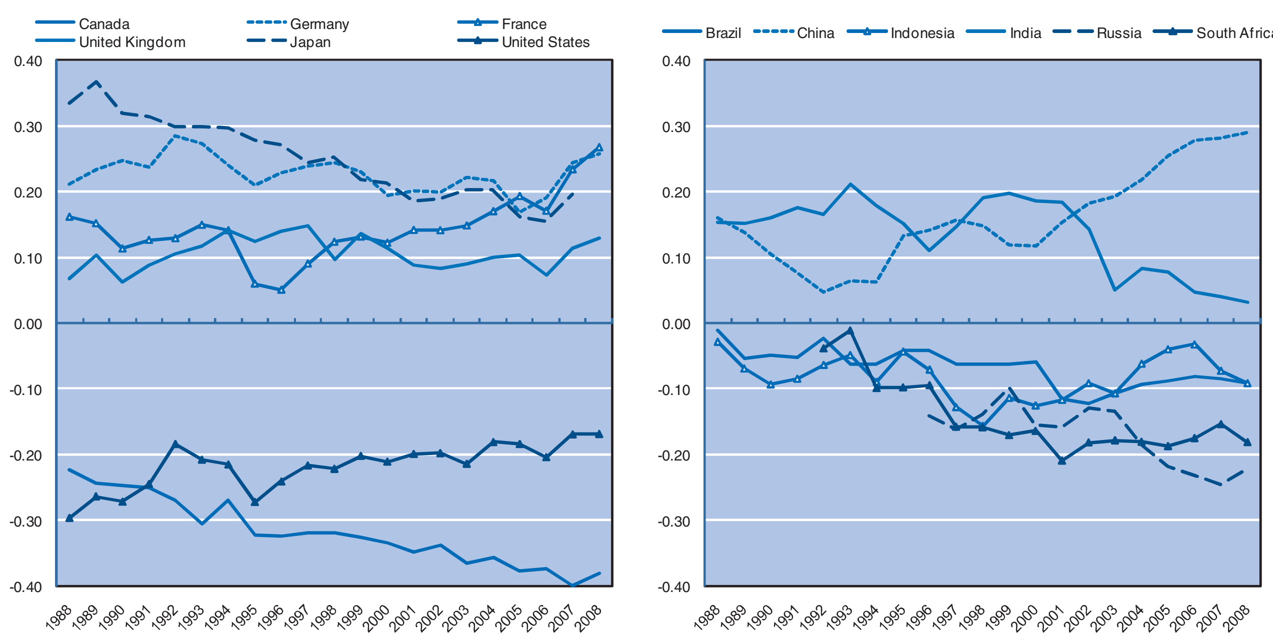
Panel G. Indonesia



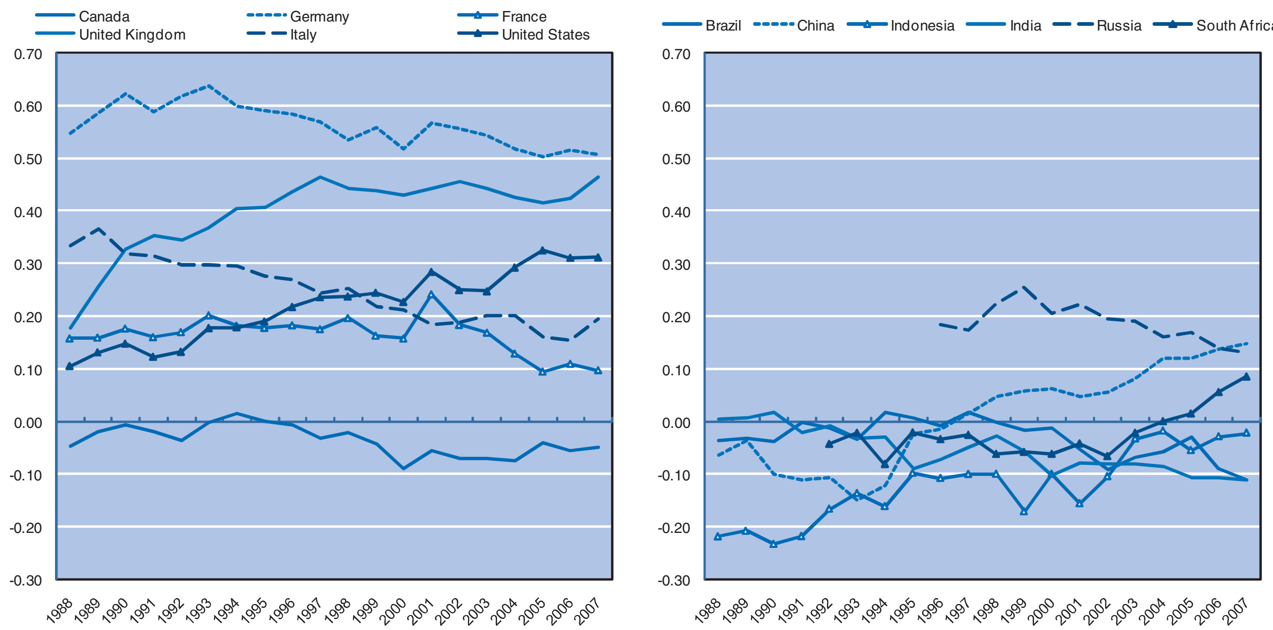
Panel I. India



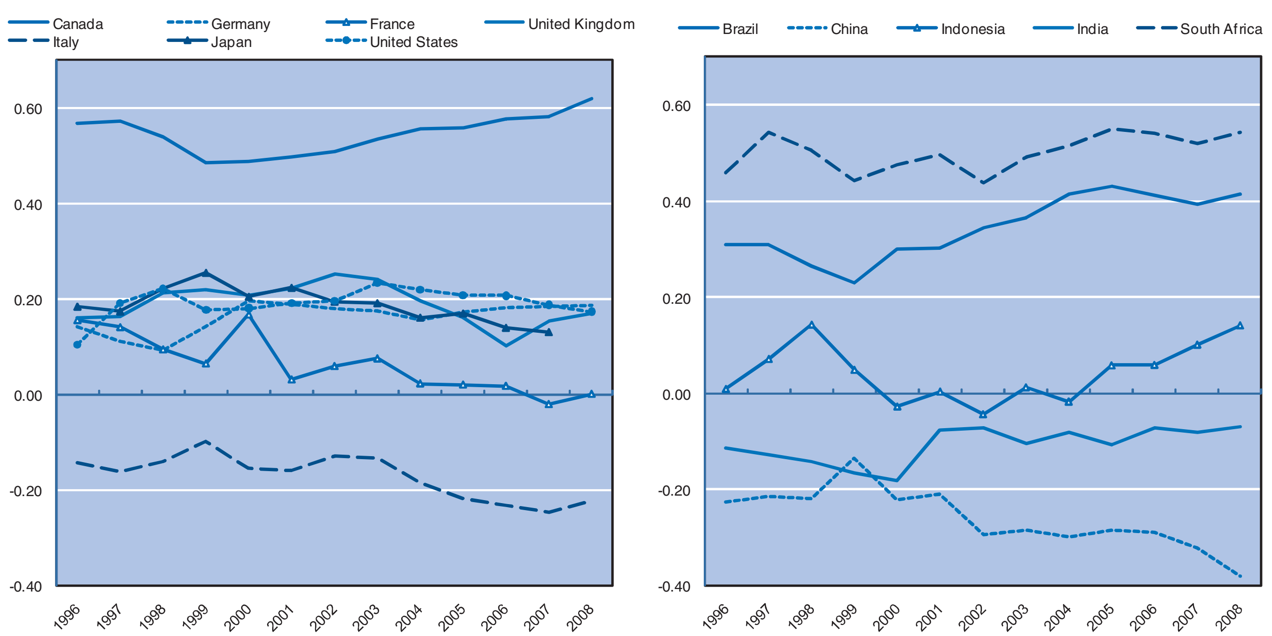
Panel J. Italy



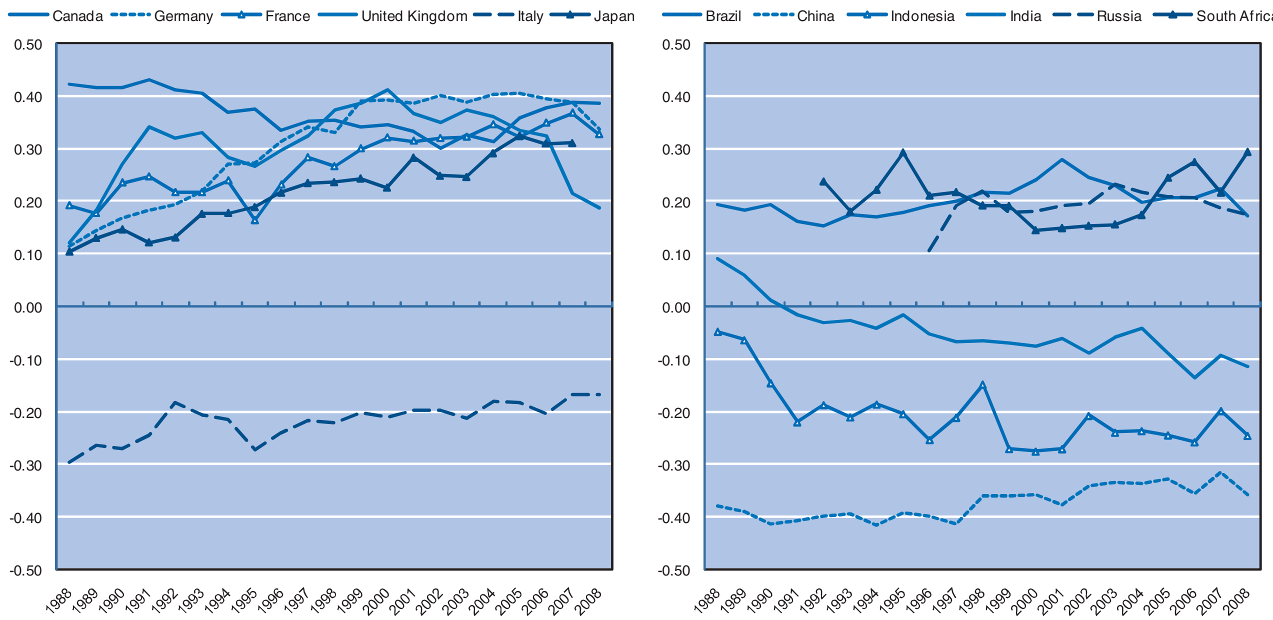
Panel K. Japan



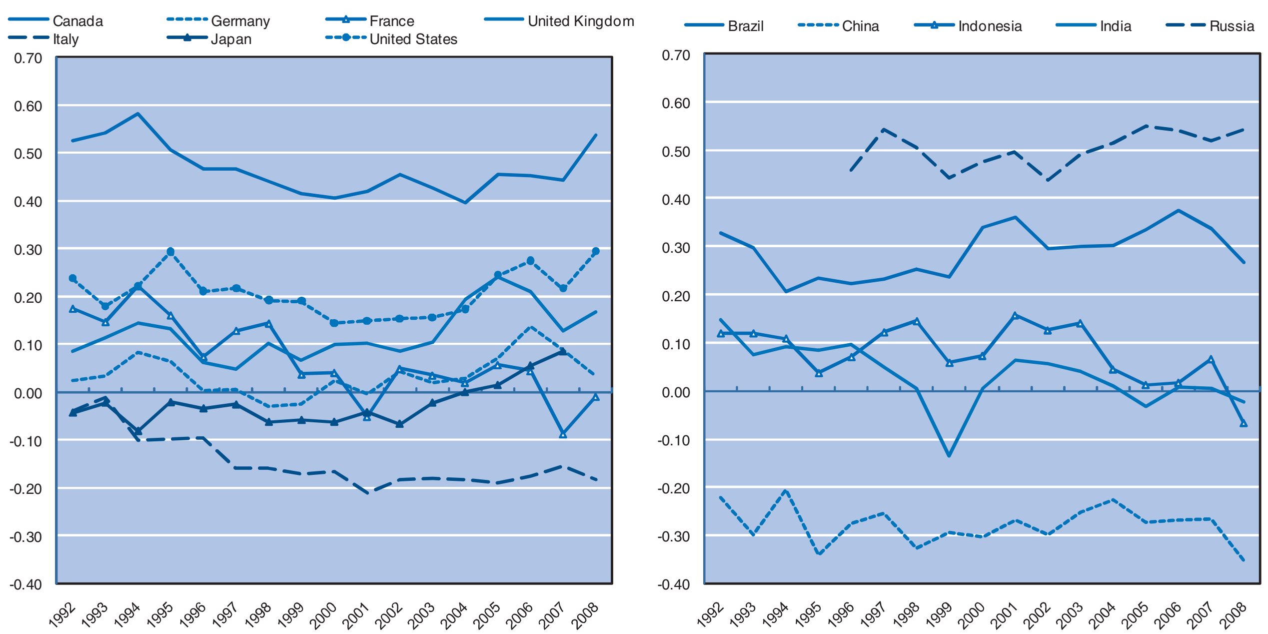
Panel L. Russia



Panel M. United States



Panel N. South Africa



Source: Authors' calculations based on UN ComTrade Database.

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Annex Table 2.A1. Revealed comparative advantage by ISIC sector, 1990

	A: Agriculture, hunting and forestry	B: Fishing	C: Mining and quarrying	D: Manufacturing	D: Manufacturing																						E: Electricity, gas and water supply	K: Real estate, renting and business activities	O: Other commu-nity, social and personal service activities	Q: Miscella-neous n.e.s
					15: Manuf. of food products and beverages	16: Manuf. of tobacco products	17: Manuf. of textiles	18: Manuf. of wearing apparel; dressing and dyeing of fur	19: Tanning and dressing of leather; Manuf. of luggage, etc.	20: Manuf. of wood and of products of wood and cork, exc. furniture	21: Manuf. of paper and paper products	22: Publishing, printing and reprod. of recorded media	23: Manuf. of coke, refined petroleum products and nuclear fuel	24: Manuf. of chemicals and chemical products	25: Manuf. of rubber and plastics products	26: Manuf. of other non-metallic mineral products	27: Manuf. of basic metals	28: Manuf. of fabricated metal products, exc. machinery and equip.	29: Manuf. of machinery and equipment n.e.c.	30: Manuf. of office, accounting and computing machinery	31: Manuf. of electrical machinery and apparatus n.e.c.	32: Manuf. of radio, television and communication equipment	33: Manuf. of medical, precision and optical instruments	34: Manuf. of motor vehicles, trailers and semi-trailers	35: Manuf. of other transport equipment	36: Manuf. of furniture; manufacturing n.e.c.				
Australia	3.309	1.826	5.561	0.554	1.937	0.089	0.648	0.109	0.305	0.718	0.123	0.474	0.980	0.266	0.185	0.210	2.932	0.340	0.192	0.272	0.204	0.110	0.263	0.180	0.319	0.289	..	0.412	0.260	6.800
Canada	1.246	1.832	2.737	0.913	0.679	0.090	0.141	0.109	0.089	4.037	3.944	0.429	1.103	0.551	0.669	0.496	1.494	0.597	0.352	0.429	0.388	0.562	0.233	2.111	0.831	0.522	2.369	0.231	0.144	0.900
Denmark	1.269	6.216	0.373	0.979	3.706	0.811	0.831	1.053	0.488	1.241	0.509	1.629	0.621	0.794	1.407	1.026	0.331	1.356	1.178	0.352	0.642	0.533	1.084	0.231	0.772	1.819	2.008	1.223	0.577	2.000
Finland	0.229	0.042	0.098	1.112	0.342	0.154	0.306	0.977	0.421	5.882	11.201	0.923	0.578	0.625	0.789	0.729	1.463	1.087	1.222	0.274	0.939	0.811	0.590	0.329	0.876	0.478	0.112	0.513	0.033	..
France	1.479	1.192	0.092	1.032	1.693	0.155	1.042	1.044	0.787	0.500	0.740	1.117	0.911	1.336	1.208	1.379	1.173	1.110	0.795	0.598	1.100	0.560	0.793	1.160	1.187	0.811	6.171	0.776	1.180	..
Germany	0.217	0.061	0.114	1.090	0.651	0.595	1.115	0.821	0.448	0.423	0.827	1.203	0.422	1.286	1.355	1.150	1.063	1.422	1.554	0.531	1.331	0.568	1.112	1.415	0.697	0.873	1.026	1.341	0.865	0.500
Greece	3.381	2.128	0.701	0.939	2.810	0.749	3.805	8.316	0.887	0.410	0.211	0.442	2.706	0.438	0.516	2.832	2.154	0.669	0.113	0.017	0.430	0.060	0.073	0.068	0.108	0.241	..	0.131	0.013	..
Iceland	0.103	57.203	0.150	0.976	10.809	..	0.294	0.707	0.043	0.003	0.031	0.040	..	0.006	0.087	0.063	2.340	0.190	0.053	0.012	0.014	0.001	0.015	0.001	0.306	0.004	..	0.044	0.136	0.300
Ireland	0.624	2.169	0.220	1.033	3.319	0.459	0.880	0.663	0.217	0.419	0.241	4.905	0.185	1.683	0.964	0.812	0.320	0.771	0.436	4.164	0.722	0.517	1.203	0.056	0.237	0.600	..	0.204	0.310	2.000
Italy	0.496	0.174	0.070	1.084	0.748	0.016	2.445	2.484	4.756	0.424	0.487	0.803	0.795	0.637	1.354	2.698	0.837	1.612	1.690	0.566	0.904	0.370	0.617	0.721	0.683	2.512	0.003	1.460	0.124	0.600
Japan	0.020	0.251	0.014	1.108	0.085	0.083	0.599	0.079	0.107	0.031	0.257	0.245	0.170	0.752	0.852	0.786	0.955	0.679	1.221	1.871	1.508	2.782	1.537	2.090	0.792	0.662	..	0.829	0.036	0.700
Mexico	2.010	0.528	8.804	0.625	0.658	0.056	0.298	0.140	0.403	0.444	0.207	0.594	1.340	0.784	0.327	1.228	1.133	0.626	0.265	0.451	0.496	0.072	0.135	1.546	0.212	0.254	1.570	0.116	0.078	0.300
Netherlands	1.930	1.387	0.863	0.948	2.371	3.225	0.760	0.716	0.412	0.371	0.829	1.388	2.825	1.510	1.132	0.775	0.777	1.113	0.571	1.210	0.615	0.495	0.692	0.360	0.542	0.560	0.078	0.306	0.357	1.800
New Zealand	3.137	4.466	0.475	0.936	7.051	0.046	2.081	0.375	1.075	3.188	1.910	0.374	0.892	0.294	0.421	0.226	1.322	0.427	0.234	0.011	0.309	0.056	0.124	0.035	0.049	0.300	..	0.057	0.091	0.600
Norway	0.073	9.605	10.397	0.548	0.784	0.078	0.162	0.076	0.099	0.878	1.531	0.207	2.178	0.222	0.375	0.398	2.031	0.606	0.343	0.223	0.343	0.158	0.249	0.107	1.387	0.262	2.915	0.197	0.232	2.600
Portugal	0.217	2.249	0.568	1.083	0.994	0.058	4.519	8.190	6.363	5.166	2.028	0.370	1.260	0.586	0.549	2.777	0.211	0.889	0.340	0.130	1.138	0.661	0.177	0.610	0.266	0.786	..	1.569	0.031	..
Spain	1.846	1.187	0.161	1.024	1.336	0.069	0.902	0.690	2.598	0.660	0.748	0.928	1.828	0.896	1.218	2.239	1.216	1.278	0.691	0.394	0.876	0.278	0.276	1.873	0.829	0.860	..	3.026	0.265	0.100
Sweden	0.142	0.564	0.337	1.015	0.289	0.093	0.385	0.272	0.184	3.421	5.279	0.686	1.157	0.663	0.956	0.659	1.348	1.433	1.202	0.549	0.913	0.897	0.947	1.073	0.526	0.767	..	0.829	0.672	3.500
Switzerland	0.086	0.036	0.660	1.061	0.389	0.929	1.205	0.467	0.395	0.333	0.596	1.223	0.035	2.223	0.987	0.565	0.673	1.571	1.918	0.211	1.362	0.275	4.144	0.101	0.186	2.354	0.024	1.982	5.539	..
Turkey	4.155	1.317	0.611	0.913	1.245	0.494	5.314	10.410	0.473	0.224	0.170	0.092	0.915	0.750	0.364	2.083	2.421	0.529	0.125	0.033	0.398	0.336	0.038	0.123	0.118	0.139	..	0.006	0.007	..
United Kingdom	0.316	1.283	1.772	0.966	0.832	1.516	0.787	0.684	0.457	0.111	0.543	1.820	1.039	1.256	0.986	0.849	0.987	0.870	1.004	1.251	0.970	0.685	1.119	0.702	1.708	0.768	0.153	1.284	4.892	0.800
United States	1.842	0.504	0.471	0.965	0.748	3.280	0.382	0.299	0.296	0.893	0.816	1.504	0.818	1.128	0.777	0.559	0.567	0.657	0.988	1.428	0.986	1.082	1.391	0.793	2.312	0.588	0.818	1.455	1.335	1.500

Source: OECD Trade Indicators database *(stats.oecd.org)*.

Annex Table 2.A2. Revealed comparative advantage by ISIC sector, 2007

	A: Agriculture, hunting and forestry	B: Fishing	C: Mining and quarrying	D: Manufacturing	D: Manufacturing																						E: Electricity, gas and water supply	K: Real estate, renting and business activities	O: Other community, social and personal service activities	Q: Miscellaneous n.e.s
					15: Manuf. of food products and beverages	16: Manuf. of tobacco products	17: Manuf. of textiles	18: Manuf. of wearing apparel; dressing and dyeing of fur	19: Tanning and dressing of leather; Manuf. of luggage, etc.	20: Manuf. of wood and of products of wood and cork, exc. furniture	21: Manuf. of paper and paper products	22: Publishing, printing and reprod. of recorded media	23: Manuf. of coke, refined petroleum products and nuclear fuel	24: Manuf. of chemicals and chemical products	25: Manuf. of rubber and plastics products	26: Manuf. of other non-metallic mineral products	27: Manuf. of basic metals	28: Manuf. of fabricated metal products, exc. machinery and equip.	29: Manuf. of machinery and equipment n.e.c.	30: Manuf. of office, accounting and computing machinery	31: Manuf. of electrical machinery and apparatus n.e.c.	32: Manuf. of radio, television and communication equipment	33: Manuf. of medical, precision and optical instruments	34: Manuf. of motor vehicles, trailers and semi-trailers	35: Manuf. of other transport equipment	36: Manuf. of furniture; manufacturing n.e.c.				
Australia	2.036	2.476	4.267	0.606	2.079	0.529	0.211	0.058	0.250	0.923	0.308	0.494	0.596	0.417	0.253	0.182	2.853	0.289	0.266	0.178	0.215	0.089	0.485	0.287	0.258	0.277	0.000	0.049	0.436	..
Austria	0.341	0.019	0.119	1.107	1.108	1.465	0.724	0.626	0.888	4.321	2.287	2.511	0.226	0.767	1.523	1.740	1.312	2.207	1.583	0.286	1.347	0.493	0.731	1.469	0.715	1.048	3.912	0.644	0.680	..
Belgium	0.750	0.309	0.558	1.073	1.338	0.861	1.006	0.686	0.991	0.897	1.047	0.892	1.104	2.662	1.169	1.225	1.268	0.797	0.731	0.188	0.505	0.237	0.548	1.205	0.256	1.084	0.595	0.437	0.189	..
Canada	1.551	2.256	2.139	0.858	0.861	0.209	0.217	0.145	0.084	3.441	3.082	0.852	1.064	0.655	0.954	0.553	1.399	0.752	0.588	0.275	0.421	0.334	0.398	1.696	1.175	0.648	3.333	0.067	1.278	..
Czech Republic	0.519	0.312	0.095	1.136	0.582	1.174	0.969	0.478	0.454	1.538	1.147	2.418	0.167	0.484	1.987	2.410	0.806	2.650	1.408	2.032	2.063	0.885	0.489	1.859	0.525	1.227	5.411	0.655	0.044	..
Denmark	1.266	5.468	0.798	1.028	3.293	1.694	0.952	1.376	0.752	1.219	0.700	1.357	0.734	1.155	1.222	1.539	0.380	1.406	1.365	0.363	1.446	0.412	1.374	0.296	0.379	1.524	2.352	0.310	0.307	..
Finland	0.325	0.147	0.026	1.154	0.365	0.033	0.243	0.183	0.193	5.115	10.176	0.944	1.181	0.635	0.856	0.972	1.823	1.007	1.429	0.211	1.238	1.897	0.763	0.509	0.982	0.235	0.796	0.270	0.040	..
France	1.246	1.120	0.074	1.093	1.742	0.595	0.718	0.803	1.064	0.707	1.131	1.135	0.732	1.464	1.306	1.159	0.863	1.082	1.022	0.306	1.114	0.434	1.073	1.367	2.566	0.640	2.838	0.998	1.361	..
Germany	0.302	0.188	0.020	1.082	0.747	1.826	0.585	0.454	0.377	0.833	1.283	1.648	0.452	1.220	1.395	1.069	0.823	1.433	1.594	0.525	1.247	0.489	1.277	1.903	0.983	0.646	1.486	2.274	0.298	..
Greece	2.704	16.524	0.116	1.025	2.510	5.145	1.904	2.774	0.389	0.478	0.489	1.071	2.749	1.150	1.353	1.879	1.922	1.253	0.454	0.155	0.850	0.224	0.278	0.267	0.390	0.380	0.494	0.216	0.142	..
Hungary	1.237	0.018	0.037	1.046	0.796	0.215	0.408	0.462	0.632	0.795	0.729	0.398	0.400	0.635	1.273	1.030	0.361	0.981	0.904	1.712	1.877	2.167	0.798	2.003	0.127	0.539	3.672	0.011	0.036	..
Iceland	0.160	27.123	0.021	1.118	8.244	0.000	0.113	0.023	0.028	0.023	0.031	0.074	0.332	0.208	0.092	0.187	4.223	0.048	0.280	0.030	0.039	0.007	0.453	0.072	5.068	0.018	..	0.004	0.265	..
Ireland	0.337	1.016	0.073	1.126	1.983	0.570	0.112	0.080	0.107	0.481	0.133	2.677	0.150	4.569	0.344	0.329	0.100	0.303	0.378	3.783	0.374	0.679	1.823	0.038	0.236	0.185	0.110	0.303	0.057	..
Italy	0.570	0.487	0.044	1.130	1.085	0.028	1.760	1.794	3.732	0.537	1.002	0.860	0.825	0.839	1.509	2.373	1.038	1.995	2.187	0.111	1.005	0.233	0.740	0.864	0.997	1.696	0.150	0.282	0.561	..
Japan	0.025	0.392	0.006	1.114	0.087	0.221	0.369	0.021	0.036	0.016	0.279	0.398	0.271	0.908	1.170	0.989	1.051	0.603	1.804	0.388	1.335	1.543	1.520	2.393	1.273	0.426	0.000	6.134	0.108	..
Korea	0.041	0.541	0.007	1.178	0.149	0.677	1.107	0.171	0.351	0.019	0.435	0.175	1.485	1.011	0.870	0.387	1.085	0.835	0.900	1.449	0.839	2.596	2.041	1.416	2.421	0.232	..	2.233	0.269	..
Luxembourg	0.439	0.354	0.021	1.104	0.877	6.519	1.403	0.470	0.104	1.838	2.198	3.364	0.024	0.432	4.011	2.909	4.385	1.162	0.888	0.569	0.750	0.490	0.409	0.694	0.252	0.237	3.137	0.183	0.057	..
Mexico	1.109	0.423	1.726	0.930	0.595	0.707	0.494	0.717	0.299	0.181	0.292	0.570	0.341	0.353	0.694	0.953	0.570	0.967	0.697	1.231	2.306	1.736	1.066	1.768	0.325	0.957	0.866	0.084	0.041	..
Netherlands	2.042	1.201	0.463	0.983	1.915	5.844	0.467	0.431	0.500	0.279	0.904	1.205	1.965	1.525	0.764	0.464	0.694	0.694	0.990	1.732	0.540	0.921	1.151	0.380	0.478	0.359	0.404	0.175	0.256	..
New Zealand	3.306	5.271	0.450	0.994	9.747	0.307	1.040	0.362	0.815	4.830	2.120	0.456	0.060	0.339	0.540	0.175	0.872	0.586	0.502	0.153	0.428	0.119	0.493	0.075	0.527	0.288	..	0.043	0.478	..
Norway	0.043	15.354	6.729	0.434	0.643	0.065	0.086	0.029	0.045	0.408	0.589	0.156	1.625	0.253	0.155	0.186	1.351	0.464	0.429	0.081	0.300	0.121	0.363	0.097	0.638	0.212	1.875	0.029	0.137	..
Poland	0.707	0.147	0.135	1.122	1.610	3.217	0.746	0.746	0.520	2.827	1.621	1.395	0.532	0.601	2.091	2.085	1.020	2.514	0.963	0.127	1.553	0.667	0.263	1.777	1.096	2.156	2.211	0.243	0.057	..
Portugal	0.591	2.253	0.178	1.055	1.405	5.824	2.744	1.955	3.369	4.318	1.136	0.473	0.882	0.615	1.775	3.581	0.602	1.674	0.628	0.324	1.064	0.892	0.234	1.253	0.408	0.978	1.042	0.294	0.121	..
Slovak Republic	0.533	0.014	0.038	1.146	0.585	0.094	0.535	0.618	1.343	1.639	1.660	0.921	1.034	0.428	1.563	1.408	1.361	1.982	0.877	0.298	1.498	1.708	0.277	2.586	0.299	0.805	..	0.359	0.002	..
Spain	2.243	2.137	0.061	1.084	1.773	0.404	0.927	0.960	1.332	0.812	1.364	1.047	0.991	1.152	1.382	2.496	1.008	1.308	0.702	0.134	1.011	0.274	0.344	2.308	1.101	0.592	0.927	0.258	0.239	..
Sweden	0.204	4.396	0.153	1.075	0.575	0.174	0.359	0.288	0.219	3.675	5.452	1.147	1.162	0.928	0.956	0.658	1.243	1.302	1.411	0.372	0.916	0.920	0.879	1.442	0.371	0.693	1.539	0.350	0.247	..
Switzerland	0.063	0.081	0.003	1.138	0.586	1.812	0.455	0.437	0.367	0.494	0.901	1.168	0.084	3.151	0.971	0.596	0.610	1.303	1.593	0.121	1.176	0.178	4.549	0.143	0.550	1.680	9.713	0.652	6.433	..
Turkey	1.604	1.149	0.168	1.104	0.959	1.161	5.421	4.098	0.485	0.502	0.542	0.204	1.049	0.305	1.586	2.760	1.684	1.706	0.785	0.034	0.924	0.328	0.097	1.677	0.823	0.930	0.763	0.112	0.008	..
United Kingdom	0.270	1.426	0.958	0.976	0.990	0.831	0.569	0.522	0.417	0.201	0.687	2.615	0.931	1.522	1.017	0.844	0.806	0.910	1.018	0.812	0.874	0.471	1.255	1.163	1.096	0.919	0.239	1.671	9.150	..
United States	1.911	0.570	0.167	1.046	0.826	0.635	0.456	0.126	0.231	0.527	1.103	1.481	0.658	1.236	0.988	0.713	0.583	0.797	1.238	1.054	1.003	0.992	1.843	1.038	2.837	1.059	0.415	1.099	3.707	..

Source: OECD Trade Indicators database *(stats.oecd.org)*.

Annex Table 2.A3. Revealed comparative advantage by service category, 1995

	205: Transportation	236: Travel	245: Communication services	249: Construction services	253: Insurance services	260: Financial services	262: Computer and information services	266: Royalties and license fees	268: Other business services	287: Personal cultural and recreational services	291: Government services
Australia	1.168	1.592	..	..	1.385	0.662	..	0.251	0.338	..	0.632
Austria	0.595	1.809	..	..	0.630	0.541	..	0.091	0.968	..	0.327
Belgium	..	..	..	..	..	..	..	..	..	..	..
Canada	0.806	0.988	..	..	4.248	0.634	..	0.248	1.157	..	0.662
Czech Republic	0.870	1.399	..	..	0.124	0.209	..	0.034	1.369	..	0.320
Denmark	..	0.863	..	..	..	..	..	..	..	..	..
Finland	1.086	0.717	..	..	-0.841	0.942	..	0.133	1.559	..	0.257
France	0.974	1.071	..	..	1.080	0.795	..	0.382	1.139	..	0.287
Germany	0.964	0.720	..	..	0.743	0.773	..	0.658	1.380	..	1.990
Greece	0.938	1.232	..	..	0.093	1.911	..	0.000	1.181	..	0.149
Hungary	0.344	1.669	..	..	0.592	0.508	..	0.101	1.786	..	0.285
Iceland	1.555	0.879	..	0.370	0.372	0.000	0.010	0.005	0.739	3.670	3.664
Ireland	0.850	1.438	..	..	0.000	0.827	..	0.456	0.925	..	1.084
Italy	0.998	1.500	..	..	1.017	1.153	..	0.254	0.534	..	0.126
Japan	1.380	0.162	..	..	0.222	0.125	..	1.594	1.928	..	0.491
Korea	1.626	0.737	..	..	-0.043	0.120	..	0.227	1.527	..	0.747
Luxembourg	..	..	..	..	..	..	..	..	..	..	..
Mexico	0.477	2.065	..	..	3.218	0.000	..	0.203	0.328	..	0.489
Netherlands	1.600	0.445	..	..	0.173	0.193	..	0.851	1.417	..	0.647
New Zealand	1.362	1.691	..	-0.120	-0.122	0.115	0.080	0.076	0.391	0.440	0.442
Norway	2.494	0.534	..	..	1.504	0.155	..	0.140	0.634	..	0.385
Poland	1.140	0.706	..	..	3.396	0.356	..	0.006	0.610	..	0.087
Portugal	0.739	1.914	..	..	0.657	0.823	..	0.041	0.444	..	0.223
Slovak Republic	1.037	0.856	..	..	0.051	1.251	..	0.079	1.384	..	0.003
Spain	0.592	2.072	..	..	1.169	0.399	..	0.085	0.551	..	0.276
Sweden	1.263	0.727	..	..	1.148	0.549	..	0.876	0.872	..	0.468
Switzerland	0.577	1.024	..	..	2.535	6.545	..	1.725	0.428	..	0.931
Turkey	0.468	1.106	..	..	0.067	0.270	..	0.000	1.243	..	0.220
United Kingdom	0.886	0.803	..	..	2.497	2.112	..	1.062	0.991	..	0.610
United States	0.829	1.125	..	..	0.282	0.847	..	2.413	0.634	..	2.132

Source: OECD Trade Indicators database *(stats.oecd.org)*.

Annex Table 2.A4. Revealed comparative advantage by service category, 2007

	205: Transportation	236: Travel	245: Communication services	249: Construction services	253: Insurance services	260: Financial services	262: Computer and information services	266: Royalties and license fees	268: Other business services	287: Personal cultural and recreational services	291: Government services
Australia	0.842	2.413	0.668	0.144	0.581	0.212	0.711	0.241	0.567	0.878	0.870
Austria	1.017	1.489	1.355	1.236	0.926	0.268	0.763	0.189	1.153	0.324	0.533
Belgium	1.473	0.601	2.201	0.680	0.495	0.464	0.868	0.288	1.217	0.325	1.397
Canada	0.847	1.078	1.819	0.117	2.234	0.319	1.606	0.802	1.073	2.230	1.256
Czech Republic	1.378	1.687	1.510	0.900	0.027	0.175	1.058	0.028	0.789	0.791	0.104
Denmark	3.046	0.442	0.695	0.233	0.237	0.035	0.504	0.461	0.601	0.660	0.591
Finland	0.662	0.536	0.831	0.803	0.235	0.180	1.792	0.752	2.266	0.057	0.262
France	1.075	1.624	1.295	1.806	0.281	0.139	0.283	0.843	0.920	0.947	0.353
Germany	1.112	0.725	0.985	2.824	1.038	0.539	1.277	0.472	1.320	0.346	1.436
Greece	2.535	1.576	0.483	0.419	0.354	0.039	0.125	0.017	0.221	0.358	0.110
Hungary	0.899	1.209	1.288	1.155	0.051	0.150	0.967	0.749	1.172	5.712	0.340
Iceland	2.132	1.065	0.284	0.000	0.214	0.010	0.953	0.000	0.997	0.278	0.286
Ireland	0.183	0.294	0.333	0.000	5.187	1.125	7.499	0.182	1.213	0.191	0.400
Italy	0.739	1.662	1.238	1.381	0.495	0.343	0.178	0.126	1.344	0.678	0.659
Japan	1.525	0.315	0.193	3.973	0.409	0.481	0.171	2.498	1.074	0.085	0.786
Korea	2.484	0.423	0.389	0.101	0.256	0.631	0.123	0.380	0.958	0.497	1.261
Luxembourg	0.250	0.271	1.448	0.368	1.417	6.659	0.463	0.083	0.422	0.672	0.288
Mexico	0.531	3.173	1.016	..	4.408	0.000	..	0.094	-0.002	1.221	0.030
Netherlands	1.153	0.519	1.688	1.125	0.214	0.153	1.306	1.707	1.454	0.424	1.109
New Zealand	1.003	2.533	0.918	0.039	0.133	0.085	0.530	0.210	0.411	1.622	0.643
Norway	2.226	0.463	0.681	0.448	0.236	0.252	1.047	0.186	1.212	0.762	0.287
Poland	1.506	1.605	0.795	2.789	0.026	0.115	0.525	0.050	0.792	0.473	0.162
Portugal	1.192	1.913	1.647	1.756	0.227	0.145	0.266	0.063	0.743	0.798	0.533
Slovak Republic	1.496	1.251	1.636	0.859	0.128	0.389	0.679	0.294	0.706	3.214	0.289
Spain	0.781	1.954	0.594	1.610	0.488	0.457	0.936	0.057	0.910	0.905	0.367
Sweden	0.819	0.826	1.261	0.806	0.576	0.292	2.338	1.037	1.503	0.365	0.414
Switzerland	0.386	0.802	0.725	..	2.858	3.085	..	1.869	0.755	0.002	1.061
Turkey	1.011	2.815	0.795	1.485	0.880	0.138	0.012	0.000	0.029	2.382	0.694
United Kingdom	0.545	0.582	1.272	0.350	1.586	2.541	1.127	0.746	1.215	0.938	0.732
United States	0.734	1.054	0.786	0.118	0.816	1.180	0.589	2.325	0.742	2.232	2.047

Source: OECD Trade Indicators database *(stats.oecd.org)*.

Chapter 3

Comparative advantage and export specialisation mobility

by
Przemyslaw Kowalski and Novella Bottini[1]

This chapter elaborates on the concept of comparative advantage and its role in economic policy and discusses its measurement, in particular with reference to the Revealed Comparative Advantage (RCA) indices. It investigates cross-sector and cross-country patterns and evolution of RCA indices for a group of 56 OECD and selected emerging economies (SEM) countries at a detailed level of product classification, covering trade in agricultural and manufactured products. In order to link export specialisation developments to some of the posited sources of comparative advantage, it classifies products according to their factor intensity which distinguishes between: primary, natural resource-intensive, unskilled labour-intensive, technology-intensive and human-capital intensive products.

The concept of comparative advantage inspired much of the economic policy making post-WWII and most notably the push for multilateral trade liberalisation under the auspices of the GATT and the WTO, as well as regional integration and unilateral trade liberalisation efforts. Yet, the policy implications of the concept have also been a subject of passionate debate that continues to this day. Higher levels of economic development have been linked in the literature with specialisation in human capital and technology-intensive products (e.g. Lucas, 1988; Young, 1991; Grossman and Helpman, 1991; Hausmann and Rodrik, 2003) and this reinforced the idea of influencing comparative advantage. But are governments capable of influencing comparative advantage in a fashion that is sustainable and beneficial for the country or should they simply facilitate the realisation of "natural" comparative advantage based on current endowments and revealed by production decisions of private firms (e.g. Lin and Chang, 2009)?

The question of influencing comparative advantage can be polarising since it is normally understood to require a preferential treatment of selected products or industries, strategy which can be associated with potential welfare costs, both domestically and internationally. Yet, some commentators argue that the case for such an intervention is quite strong (Rodrik, 2008), especially since even horizontal policies that do not have a sectoral focus may influence country's comparative advantage. A government may accept the concept of comparative advantage but it may still consider supporting an industry which may be efficient in the future if it is helped in the "infant" phase. Alternatively, a government may acknowledge the potential difficulty in establishing where the comparative advantage may lie in the future or the danger of associated rent-seeking behaviour, and may instead focus on reducing costs and improving conditions horizontally for all sectors (Lin in Lin and Chang, 2009).

A number of other hypotheses have been competing with comparative advantage for policy makers' attention. Strategic trade policy literature of the 1980s emphasised economies of scale and provided a theoretical case for government intervention (Krugman, 1987). Economic geography literature of the 1990s emphasised factor mobility and the fact that the structure and volume of trade can be determined by geographic agglomeration of economic activity based on initial conditions and trading costs (e.g. Krugman and Venables, 1995). Business literature has devoted much attention to the hypothesis of competitiveness which posits that it is not so much the comparative costs that should be the focus of country's economic policies but rather the competitive advantage, or the ability to perform at a higher level of productivity than others in the same industry or market (Porter 1990).[2]

Along similar lines, Freidman (2005) argued that the "world is flat", a commercial level playing field where historical and geographical divisions are becoming increasingly irrelevant and all competitors have an equal opportunity. This approach puts emphasis on inter-individual and inter-company competition and rendering comparative advantage largely irrelevant. Its legacy takes the form of pleas for promotion of "high technology" or "high value added" production, often without a meticulous consideration of where the comparative advantage of a country may lie. The danger of such an approach is that it may lead to a wasteful use of public expenditure and protectionist policies designed to promote premature development of high technology industries, especially in developing countries (e.g. Warr, 1994). The recent *Development Policy Review Debate* between Justin Lin and Ha-Joon Chang summarises these various arguments and reveals that the debate on policy-relevance of comparative advantage is still at the centre of policy considerations, and far from settled (Lin and Chang, 2009).

The present chapter aims to inform this debate by analysing developments in export specialisation patterns in the OECD and major selected emerging market (SEM) economies during the period 1990-2007 and by discussing how they relate to trade and other aspects of economic performance. The section first elaborates on the concept of comparative advantage and the role it has played in thinking about effects of international trade and effects of economic policies. Subsequently, measurement of comparative advantage is addressed, in particular with reference to one commonly used group of indices, i.e. the Revealed Comparative Advantage (RCA) indices. We discuss how these indices relate to the original concept of comparative advantage, discuss their meaning and key limitations of their use. The empirical part of this chapter investigates cross-sector and cross-country patterns and evolution of RCA indices for a group of 56 OECD and SEM countries at a detailed level of product classification, covering trade in agricultural and manufactured products. In order to link export specialisation developments to some of the posited sources of comparative advantage, we classify products according to their factor intensity which distinguishes between: primary, natural resource-intensive, unskilled labour-intensive, technology-intensive and human-capital intensive products. Such a comparison, spanning across the OECD and SEM countries and performed at a detailed disaggregated levels (4-digit HS classification), has not been attempted so far.

Comparative advantage hypothesis and economic policy

The comparative advantage hypothesis had a fundamental influence on shaping economic development policies post-WWII, though policy prescriptions derived on its basis depended on contemporary economic circumstances and their understanding at the time and thus saw a remarkable evolution over the decades.

The most straightforward policy implication of the comparative advantage hypothesis is that trade barriers need to be lifted and that this needs to be accompanied by policies facilitating the associated structural adjustment so that price signals associated with policy reforms can bring about the gains from trade, while minimising any potential social costs. However, even if trade liberalisation is undertaken, gains from trade may be partial if the structural change associated with realisation of comparative advantage is impeded. Therefore, governments have been long advised to accompany trade reforms with appropriate trade and structural adjustment policies to facilitate the structural change and minimise any potential social costs. OECD (2005) summed up the key elements of a policy framework conducive to trade-related structural adjustment. They included: macroeconomic policies that promote stability and growth; labour market policies that help develop skills and facilitate labour mobility and provide assistance to those who experience difficulties; business friendly regulatory framework; a governance framework that favours and promotes structural reform; and liberal trade and investment policies that support structural adjustment. Chapter 11 in this volume expands on some of these issues.

Yet, the acknowledgement of the comparative advantage hypothesis has not always resulted in pleas for minimizing the state's intervention in the economy or free trade. For example, comparative advantage has also a key consideration of the import substitution policy of 1950s and 1960s, which embraced strong protectionist measures. At the very general level, the import substitution posited that free trade based on comparative advantage, under economic conditions prevalent at that time,[3] would leave underdeveloped countries specialised in primary commodities which was then considered synonymous with low living standards (Krueger, 1997). It thus called for import protection in areas where imports competed with domestic production (predominantly manufacturing) since, as it was believed, new industries in poor countries could not be able to compete with their counterparts in industrialised countries.

The case for import substitution rested strongly on the infant industry argument, which has always had a strong influence on the analysis of policy implications of the comparative advantage hypothesis. The infant industry argument posits that because of dynamic considerations, externalities or large fixed costs an economically viable industry would not be established by private agents in the absence of some form of help or a subsidy from government. Technically, the argument is about correcting negative externalities or about economic efficiency in dynamic perspective and makes a case for a production subsidy, not necessarily trade protectionism as in the case of the import substitution policies.[4]

The infant industry argument, also referred to in literature as industrial policy, is a key concept in debates about "dynamic comparative advantage." A government may accept the concept of comparative advantage but it may still consider supporting an industry which it thinks may be efficient in the future if it is helped in the 'infant' phase, thus influencing realisation of comparative advantage. This seemingly straightforward proposition proved extremely controversial. The Washington Consensus of the early 1980s has led to promotion of structural adjustment programmes which promoted the power of markets over states in resource allocation and dismantling of policy regimes which were designed to promote industrial policy (Barnes *et al*., 2003). This contrasted with the experience of some highly performing Asian economies[5] and triggered a research inquiry into the sources of their economic success. The resulting report (World Bank, 1993) concluded that targeted industrial policies had been a failure and that the only viable role Asian governments had played was to promote economy-wide initiatives to correct market failures. Since then, this negative conclusion and the analytical process that led to it have been questioned on several occasions (e.g. Lall, 1994; Rodrik, 1994; Stilglitz, 1996).

In a recent survey Rodrik (2009) takes stock of the industrial policy debate and argues that there is a strong theoretical case for it, based on correcting market imperfections.[6] Rodrik argues that the case against it does not address the central premise of the need or government's ability to help an industry become viable in certain circumstances, but rather rests on practical difficulties with its implementation. Firstly, governments may be incapable of correctly identifying the "winners" and, secondly, industrial policy may trigger unwanted rent-seeking behaviour. These potential problems have been identified as particularly dangerous for developing countries which would like to emulate the benefits obtained from industrial policy by some Asian economies but which do not have as capable bureaucracies and the political ability to withdraw stimulating measures at the right time (Pack, 2000).

Many cases of industrial policy have been documented in the literature. A positive account of South Africa's Motor Industry Development Programme has been given by Barnes *et al.* (2003). Chang in Lin and Chang (2009) described the four decades long protection of the Japanese car industry by high tariffs, direct and indirect subsidies and restrictions on foreign direct investment before it became competitive in the world markets. Nokia group was cross-subsidised by its sister companies before it started making profits (Lin and Chang, 2009). Korean state owned firm POSCO benefited from import substitution-type of policies and the Brazilian aircraft company Embraer was established and developed into a global competitor through state ownership and export subsidies (Rodrik, 2009). Notwithstanding these and numerous other examples, a significant scepticism persists about whether such specific examples constitute a case for a general recommendation of targeted industrial policy. Overall, the debate at present on industrial policy remains "hung up on the question *should we or should we not?*" (Rodrik, 2009).

To complicate matters, recent literature demonstrates that even horizontal policies that do not have a sectoral focus influence country's comparative advantage. Indeed, all known sources of comparative advantage can be influenced by policy. Policies have been demonstrated as playing an important role in shaping the size and quality of available stocks of factors of production (labour, or land or capital) as well as in influencing ways in which these factors are combined in the productive process. Rodrik (2009) argued that in fact not a single type of economic policy is truly horizontal, i.e. having equal impact across all productive sectors. This is in line with the most recent developments in the literature on comparative advantage that emphasize various broad policy and regulatory areas which impact upon the relative costs of producing certain goods and services across countries. For instance, policies resulting in greater flexibility of labour market adjustments were found to create conditions for development of comparative advantage in industries with varying levels of demand volatility (e.g. Cunat and Melitz, 2007). Nunn (2007) found that the quality of legal systems proved to be an important determinant of trade flows. Countries with better financial systems were found to have more efficient sectors with higher financial requirements (Manova, 2007 and 2008). Helpman (2010) emphasises heterogeneity within industries and differences across countries in labour market frictions as an important source of comparative advantage.

The comparative advantage hypothesis has long inspired policy makers but not only as a static concept. First, it can be affected by a host of phenomena over which governments may or may not have control. These include: processes that lead to factor accumulation especially ones that lead to a change in country's relative factor abundance; endogenous technological change, knowledge spillovers or technology transfer; as well as processes associated with geographical agglomeration or dispersion of economic activity if they result in changes in relative costs of production. Second, there is ample evidence that relative costs of production can be influenced by targeted policies (e.g. direct and indirect subsidies, trade protection, industrial policy) as well as horizontal polices (e.g. labour and capital market policies, quality of law, etc.). Third, as a relative concept, comparative advantage of a country is influenced indirectly by all the above developments in its trading partners.

Bearing in mind the multiple factors that influence relative costs of production, the reminder of the chapter aims to characterize the key features of comparative advantage dynamics for a group of OECD and SEM economies, starting with the discussion of its measurement.

Measurement of comparative advantage and meaning of RCA indices

In the seminal paper that gave birth to the empirical literature on the Revealed Comparative Advantage (RCA) Balassa (1965) observed that the most direct way of ascertaining the pattern of comparative advantage would be through inter-country cost comparisons based on internationally comparable industrial censuses or through comparison of autarchic and free trade relative prices (Balassa, 1965). The only such cost comparison that existed at the time was the Organisation for European Economic Co-operation study (OEEC, 1958) that covered the United States and the United Kingdom in 1950 and, according to Balassa, suffered from methodological problems. Comparison of autarchic and free trade prices was yet more elusive as neither of these can be directly observed.[7] Moreover, Balassa (1965) argued, neither the comparative costs, nor the autarchy price approach would be capable of capturing the non-price determinants of comparative advantage such as quality differences, goodwill or the availability and quality of servicing and repair.

In this context Balassa (1965) proposed that comparative advantage would be expected to determine the structure of exports[8] and that export flows can be used to evaluate export performance of individual industries with the use of export-performance indices. Later these indices were dubbed in the literature as 'revealed comparative advantage' (RCA) indices[9] and have been commonly used to measuring comparative advantage. Balassa's approach was to use normalised export shares to evaluate export performance of individual industries. This normalisation was executed by dividing the export share of country i in world exports of individual commodity j by the country's share in the combined world exports of manufactured goods ((a) in Equation 1). Alternatively, the same index could be expressed as the ratio of commodity j's share in country i's total exports and j's share in world total exports [(b) in Equation 1].

$$RCA_{ij} = \frac{\frac{X_{ij}}{X_{wj}}}{\frac{X_i}{X_w}} \ (a) = \frac{\frac{X_{ij}}{X_i}}{\frac{X_{wj}}{X_w}} \ (b) \tag{1}$$

As evident in formulation (a) of Equation 1 an RCA index greater than 1 (RCA>1) reflects the situation where the weight (or concentration) of a given product in the country's exports is higher than the weight (concentration) of this product in world exports. Such a situation is interpreted as an indication of 'revealed comparative advantage'. Thus, for example, it would be expected of a country to have a larger share in the export of those goods which are produced with factors it holds in relative abundance.

Yet, this interpretation is associated with several caveats. First, as can be seen in equation 1, the upper bound of the RCA index either varies by country and is fixed across sectors (a) or varies by sector but is fixed across countries (b). The implication of this is that the index is suitable for either cross-sector comparison within the same country or for a cross-country comparison within the same sector. A simultaneous cross-sector cross-country comparison needs to be approached with caution. We can say an RCA of 2 for Germany's product *A* compared to an RCA of 3 for Germany's product *B* indicates a stronger export performance, higher degree of export specialisation, and a higher degree of revealed comparative advantage of Germany's product *B*. We can also say that an RCA of 4 for France's product *B* would indicate a higher degree of export specialisation and better export performance of France in the same product *B*. What we could not say is that an RCA of 4 for France's product *B* compared with an RCA of 2 for Germany's product *A* indicates a better export performance of the former as compared to the latter.

The latter restriction is related to the fact that in a simultaneous cross-country, cross-sector and cross-time comparison both nominator and denominator vary, calling for a consideration of the joint effect. Hence, for example, an increase in an RCA index value between two time periods could entail both a decrease in sectoral export share and an increase in country's share in world exports. In an empirical analysis this problem can be overcome with some of the statistical tools that consider the whole distribution of the RCA index and its evolution over time, such as the transition probability matrices or ergodic distributions. This is the approach taken in the remainder of this chapter.

As long as we remember about these caveats the index can be used as a cardinal, ordinal or a dichotomic measure of relative export specialisation. As an ordinal measure it allows ranking the index on the base of its value and asserting which sectors' (of an individual country) had a stronger export performance. As a cardinal measure we can use RCA indices to directly compare two values of the index and measure their difference.[10] Hence, for example, twice as large an RCA for product A indicates twice as high a country's normalised export share in world market. Finally, the dichotomic interpretation of the index allows us distinguishing sectors with revealed comparative advantage (RCA>1) to sectors with revealed comparative disadvantage (RCA<1).

The RCA index is itself a ratio of export shares, which have attracted attention on their own. Indeed, export shares do often get analysed in studies of trade performance. A rise in a country's share of the world market for a particular product *j* (X_{ij}/X_{wj}) – the numerator of the RCA index – is sometimes interpreted as an indication of country's commercial success or competitive edge in this product category. A rise in a country's overall share in world exports (X_i/X_w) – the denominator of the RCA index – has also been interpreted as an indication of a country's general commercial success.[11] An increase in the RCA index in this context reflects a situation where a commercial success of a particular product category exceeds the commercial success of a country as a whole.[12]

It has to be emphasised, however, that these interpretations are only loosely related to what trade theory tells us about the benefits of trade. Comparative advantage-based trade theories do not give any interpretation of product export shares –they only posit that countries will gain from specialisation according to comparative advantage so that welfare gains are associated equally with products that country exports (large relative export shares) as with those that country imports (small relative export shares). Similarly, theory does not provide any indication with respect to what a country's overall share in world trade should be, except that in most analytical frameworks this share is related to country's size.

Further investigation of some properties of the index presented in Annex 3.A reveals a number of interesting implications concerning the relationship between relative product export shares and country's overall world export share. First, whether an increase in country's share in world trade occurs depends on whether individual product shares increase on average, where average is weighted by product shares in world trade (X_{wj}/X_w). Secondly, a given percentage point increase in the world market share for a particular product of a given country results, ceteris paribus, in a larger impact on our measure of revealed comparative advantage the less traded worldwide the given product is. At the same time, a given percentage point increase in the world market for a particular product results, ceteris paribus, in a larger impact on country's share in world trade the more traded the given product is worldwide. Finally, for any country the weighted average of RCA indices across the product space equals one, weights being again shares of particular products in world trade.[13] Overall, however, any pattern of changes in RCAs across the product space consistent with the above-stated conditions could lead to an increase in country's share in world trade. This property of the index is another indication of its approximate relation to theory.[14]

In conclusion, the RCA index is not a measure of comparative advantage that is strictly derived from any particular trade theory but this does not disqualify its usefulness as an analytical tool that can guide evidence-based policy discussions. Admittedly, the index is influenced by a multitude of factors, including country's natural characteristics (e.g. the amount of land available per head of population, based on current demographics) as well as economic policies which may benefit certain sectors more than others (e.g. infrastructure or R&D expenditures), irrespective of whether such policies are welfare enhancing or sustainable in the long term. Yet, it would be rather demanding, if at all desirable, to expect a general index to filter out all welfare reducing factors without filtering out the welfare enhancing factors, or vice versa. After all, as discussed above, the policy implications of the comparative advantage hypothesis remain somewhat vague. The uncomplicated and transparent nature of the index is its advantage that undoubtedly contributed to its popularity in applied trade analysis. It can help policy makers identify important trends that can be studied further using additional information on specific sources of comparative advantage or country or industry-specific information. This is the approach of the empirical investigation presented in the remainder of this chapter.

Overview of export specialisation patterns by broad sector

In what follows we present cross-sector and cross-country patterns and time evolution of RCA indices computed for a group of 56 OECD and Selected Emerging Market (SEM) countries[15] at 1, 2 and 4-digit level of the HS 2002 classification, based on the data extracted from the UN Comtrade.[16] The period considered in this analysis, 1990-2007, has been chosen to maximize both data availability and to cover most recent years. In order to link export specialisation developments to most prominent sources of comparative advantage identified in the literature we consider a classification of products according to factor intensity compiled by Hinloopen and van Marrewijk (HvM). [17]

First, in order to characterise broad patterns of specialisation we consider a "1-digit" sector classification based on grouping of 2-digit HS products (Annex Table 3.A1). RCA indices computed for this classification for 1993, 2000 and 2007 are presented in Annex Tables 3.A2-3.A4 and Table 3.1 below lists the top ten and bottom ten countries in 2007 according to the values of the RCA indices for each broad product category. Table 3.2 presents some summary statistics for the same set of RCA indices. In what follows we give a quick summary of some of the highlights.

The RCA patterns are in line with what is broadly known about relative factor endowments and levels of economic development of countries in our sample (e.g. Chapter 5). For example, OECD countries almost entirely dominate the top ten RCA lists for *Machinery and electrical products* (HS 84-85) and *Transportation products* (HS 86-89), the two categories mostly composed of technology-intensive and human and physical capital-intensive products. The top ten RCA lists for *Textiles (HS 50-63)* and *Footwear and Headgear* (HS 64-67) which are primarily considered as unskilled labour-intensive products are dominated by SEM economies, including Tunisia, India, Morocco, Vietnam and China and by a narrow group of OECD textiles producers including Turkey, Portugal, and Italy. While these patterns make intuitive sense, there are also several cases of OECD countries specialising strongly in primary and natural resource-intensive products, while several SEM economies are strongly specialised in products with high technology and human capital content.

Table 3.1. Top ten and bottom ten countries according to RCA index in 2007 by broad product

Animal & Animal Products (01-05)		Vegetable Products (06-15)		Foodstuffs (16-24)		Mineral Products (25-27)		Chemicals and Allied Industries (28-38)		Plastics / Rubbers (39-40)		Raw Hides, Skins, Leather, and Furs (41-43)		Wood and Wood Products (44-49)		Textiles (50-63)		Footwear / Headgear (64-67)		Stone / Glass (68-71)		Metals (72-83)		Machinery / Electrical (84-85)		Transportation (86-89)		Miscellaneous (90-97)	
Top 10 countries with highest RCA index																													
ISL	36.2	MAR	5.7	GRC	5.3	MAR	14.4	MAR	2.9	THA	2.8	GRC	5.8	PRT	6.3	TUN	4.3	VNM	8.1	ZAF	3.9	LUX	4.3	ITA	2.0	UKR	5.9	CHE	4.0
NZL	25.0	VNM	5.3	ARG	4.3	ZAF	8.5	TUN	2.8	LUX	2.3	NZL	5.3	EST	5.9	TUR	4.2	TUN	5.2	CZE	2.2	UKR	3.2	CHE	2.0	ISL	3.2	HKG	2.8
MAR	10.4	ARG	4.9	MAR	3.9	EGY	7.0	IRL	2.5	MYS	1.8	HKG	4.7	FIN	4.9	IND	3.5	PRT	4.7	CHE	2.2	ZAF	2.0	AUT	1.7	SVK	2.2	IDN	1.8
TUN	10.4	ISL	4.0	THA	3.4	UKR	4.8	CHE	2.1	BEL	1.7	DNK	3.7	SWE	3.1	MAR	3.5	CHN	4.3	PRT	2.0	SVN	2.0	JPN	1.6	AUT	1.9	CHN	1.7
NOR	6.1	TUN	3.8	BRA	3.4	GRC	4.7	ISR	2.0	IDN	1.7	IND	3.4	IDN	2.8	VNM	3.3	IDN	3.9	IND	2.0	AUT	1.8	CZE	1.6	POL	1.8	MYS	1.6
DNK	4.8	IND	3.7	NZL	2.5	AUS	4.4	BEL	1.9	SVN	1.5	ITA	3.1	NZL	2.8	CHN	2.9	MAR	3.1	ISR	1.9	GRC	1.8	DEU	1.5	SVN	1.7	USA	1.4
VNM	4.5	IDN	3.7	ISL	2.5	IND	4.3	IND	1.6	POL	1.5	AUS	2.6	AUT	2.1	IDN	2.4	HKG	2.7	AUT	1.8	IND	1.6	FIN	1.5	CZE	1.7	EST	1.4
GRC	4.1	EGY	3.6	UKR	2.1	ISL	3.8	ZAF	1.6	DEU	1.4	EST	2.3	POL	2.0	HKG	2.2	ITA	2.3	LUX	1.7	CHL	1.5	SVN	1.5	ESP	1.6	JPN	1.3
AUS	3.8	ESP	2.9	TUR	2.0	CHL	3.5	USA	1.5	VNM	1.3	FIN	2.2	CZE	2.0	PRT	2.2	IND	1.8	THA	1.6	CHN	1.5	DNK	1.4	USA	1.5	ITA	1.2
ARG	3.4	TUR	2.8	DNK	2.0	KAZ	3.5	NLD	1.5	FRA	1.3	VNM	2.2	CAN	1.8	ITA	1.9	SVK	1.4	TUR	1.5	CZE	1.5	SWE	1.4	FRA	1.5	GBR	1.2
Bottom 10 countries with lowest RCA index																													
EGY	0.3	SGP	0.3	SGP	0.3	NZL	0.6	HUN	1.5	IRL	0.3	NOR	0.3	JPN	0.3	ISL	0.3	IRL	0.1	KOR	0.4	TUN	0.7	IRL	0.4	AUS	0.4	LUX	0.3
FIN	0.3	SWE	0.5	ARE	0.3	MEX	0.5	EGY	0.3	NZL	0.3	SWE	0.3	IND	0.3	FIN	0.2	AUS	0.1	NLD	0.4	HKG	0.6	NOR	0.3	MYS	0.3	BRA	0.3
JPN	0.3	FIN	0.3	FIN	0.3	ISR	0.4	TUR	0.4	SAU	0.3	EGY	0.3	EGY	0.3	CAN	0.2	ARG	0.1	CHL	0.3	ARE	0.6	AUS	0.3	SAU	0.3	ZAF	0.3
SGP	0.3	RUS	0.3	RUS	0.3	HUN	0.4	SVK	0.6	ARE	0.2	SAU	0.2	IRL	0.3	SGP	0.2	NOR	0.1	KAZ	0.3	NOR	0.5	ARE	0.2	ARE	0.3	EGY	0.2
RUS	0.2	NOR	0.2	KOR	0.2	SGP	0.4	LUX	0.7	AUS	0.2	JPN	0.1	SGP	0.2	IRL	0.1	CHL	0.1	ARG	0.3	NZL	0.5	ARG	0.2	MAR	0.2	UKR	0.2
SAU	0.2	HKG	0.1	NOR	0.2	JPN	0.4	NOR	6.1	ISL	0.2	RUS	0.1	KOR	0.2	CHL	0.1	RUS	0.0	SGP	0.3	SGP	0.5	RUS	0.2	IRL	0.2	ARG	0.1
ARE	0.2	CHE	0.6	KAZ	0.2	IRL	0.3	HKG	0.6	CHL	0.2	MYS	0.1	SAU	0.2	NOR	0.1	EGY	0.0	IRL	0.3	VNM	0.5	CHL	0.0	CHL	0.1	RUS	0.1
KAZ	0.2	KOR	0.2	SAU	0.2	KOR	0.3	ISL	36.2	MAR	0.2	CHL	0.1	ARE	0.2	SAU	0.1	SAU	0.0	NZL	0.2	ARG	0.5	KAZ	0.0	KAZ	0.1	CHL	0.0
ISR	0.2	SAU	0.2	HKG	0.1	CHE	0.2	VNM	4.5	NOR	0.1	LUX	0.1	ISL	0.1	KAZ	0.1	ISL	0.0	SAU	0.2	IRL	0.3	SAU	0.0	HKG	0.1	SAU	0.0
CHE	0.1	JPN	0.1	JPN	0.1	HKG	0.1	ARE	0.2	KAZ	0.0	ISR	0.0	KAZ	0.0	RUS	0.1	KAZ	0.0	NOR	0.2	SAU	0.1	EGY	0.0	EGY	0.0	KAZ	0.0

Source: Data from UN ComTrade, authors' calculations.

Table 3.2. Summary statistics of RCA indices by broad sector

	Animal & Animal Products (01-05)	Vegetable Products (06-15)	Foodstuffs (16-24)	Mineral Products (25-27)	Chemicals and Allied Industries (28-38)	Plastics / Rubbers (39-40)	Raw Hides, Skins, Leather, and Furs (41-43)	Wood & Wood Products (44-49)	Textiles (50-63)	Footwear / Headgear (64-67)	Stone / Glass (68-71)	Metals (72-83)	Machinery / Electrical (84-85)	Transportation (86-89)	Miscellaneous (90-97)
Maximum value of RCA across countries															
1993	55.6	7.1	6.5	19.9	3.9	1.8	8.9	6.3	5.0	6.6	4.2	2.6	1.8	3.0	2.9
2000	54.6	8.7	8.1	16.4	3.9	2.9	7.3	5.8	6.0	14.9	5.0	6.2	2.1	2.8	3.4
2007	36.2	5.7	5.3	14.4	2.9	2.8	5.8	6.3	4.3	8.1	3.9	4.3	2.0	5.9	4.0
Minimum value of RCA across countries															
1993	0.1	0.1	0.1	0.2	0.0	0.1	0.1	0.1	0.0	0.0	0.1	0.1	0.0	0.0	0.0
2000	0.0	0.1	0.0	0.2	0.0	0.0	0.1	0.0	0.0	0.0	0.2	0.0	0.0	0.0	0.0
2007	0.1	0.1	0.1	0.1	0.1	0.0	0.0	0.0	0.1	0.0	0.2	0.1	0.0	0.0	0.0
Standard deviation of RCA across countries															
1993	9.2	2.0	1.7	3.6	0.8	0.4	2.0	1.4	1.4	1.6	0.7	0.6	0.5	0.6	0.6
2000	7.9	1.9	1.5	2.8	0.7	0.6	1.7	1.2	1.5	2.3	0.9	1.1	0.5	0.6	0.7
2007	6.0	1.4	1.1	2.4	0.6	0.6	1.3	1.3	1.1	1.6	0.7	0.7	0.5	0.9	0.7
Coefficient of variation across countries															
1993	2.4	0.9	1.0	1.3	0.7	0.6	1.1	1.0	1.0	1.3	0.7	0.6	0.7	0.8	0.9
2000	2.6	1.1	1.0	1.2	0.7	0.6	1.1	0.9	1.1	1.8	0.8	0.9	0.6	0.7	0.9
2007	2.2	1.0	0.8	1.2	0.7	0.6	1.1	1.0	1.0	1.6	0.6	0.6	0.6	0.9	0.8

Source: Data from UN ComTrade, authors' calculations.

The coefficients of variation[18] indicate that the highest degree of RCA variation are observed for a number of primary and unskilled labour-intensive product categories such as *Animals and animal products*, *Mineral products* or *Footwear / Headgear* and *Textiles,* suggesting further that these traditional products may offer greater potential for trade specialisation. This could be because of the role played by natural conditions (e.g. mineral products) or unskilled labour content, or because of the degree of these products' differentiation or tradeability. Much less variation is observed in technology and human capital-intensive product categories such as *Chemicals and Allied Industries*, *Plastics and Rubbers* and in *Machinery and Electrical* products. These industries tend to be more footloose in nature and are characterised by more complex value chains that transcend national borders.

Coefficients of variation capture unevenness of specialisation patterns but do not tell us much about how specialisation patterns may have been changing over time. A first pass at this is to investigate whether there have been any switches from the status of revealed comparative advantage to revealed comparative disadvantage (or *vice versa*). Annex Tables 3.A5-3.A6 summarise the information on changes in RCA indices from values indicating revealed comparative disadvantage (RCA< 1) to values indicating revealed comparative advantage (RCA>1) over the period 1993-2007.[19] Focusing on the sub-period 2000-2007 for which we can compare a larger subset of countries from our OECD and SEM groupings, there is a considerable degree of stability in countries' export specialisation; in a large number of cases wherever a country displayed a revealed comparative advantage or disadvantage in 2000 it would still display the same status in 2007.[20] There are also several instances of countries developing revealed comparative advantage in products where it did not exist in the past, and vice versa but these changes are not large. Formal testing of statistical significance of these changes is not attempted,[21] but we make an observation that the changes are smaller than one standard deviation calculated across countries and sectors.[22] Thus, at 1-digit level of the HS 2002 classification specialisation patterns seem remarkably stable.

Dynamics of specialisation at the product level

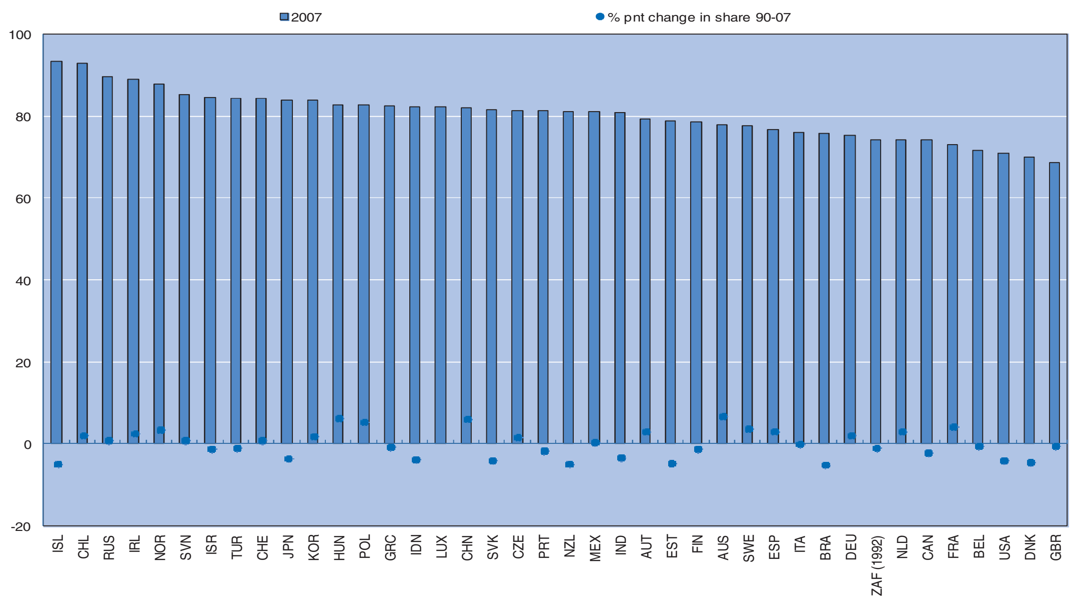
Analysis at the broad industry level helps establish general trends but RCA indices calculated for broad product categories may mask potentially interesting developments at the product level. For example, in South Africa in the broad *Mineral Products* category, which as an aggregate industry shows a very high degree of export specialisation in 2007 (RCA of approximately 8.5), only about 50% of 4-digit products have RCAs above one. Moreover, in the *Animal Products* industry, which as an aggregate industry displays comparative disadvantage (RCA of 0.9), up to 20% of 4-digit products have RCAs above 1. Similarly, in Brazil less than 40% of 4-digit products in the broad *Foodstuffs* category (RCA of approximately 3.4) have RCAs above one and more than 10% of products in the *Chemicals and Allied Industries* (RCA of approximately 0.8) have RCAs above one.

Similar examples can be found for other countries and industries making a case for an analysis at the product level. The remainder of this section follows the approach of Proudman and Redding (2000) and analyses changes in the external shape of RCA distribution and intra-distributional dynamics at 4-digit level of HS product classification. The basic idea of studying the external shape of RCA distribution is to consider the entire spectrum and density of values of specialisation index instead of just focusing on values obtained for particular product categories or selected summary statistics. This enables an investigation of intra-distributional mobility of products as well as a verification of some distributional properties posited by theory such as for example the hypothesis of relatively higher polarisation of trade specialisation patterns in emerging economies suggested by the endogenous growth and trade literature (Brasili *et al.*, 2000). Such a comparison, spanning across the OECD membership and a group of approximately twenty selected SEM economies, and performed at a fairly high level of product detail has not been done so far. Another innovation is to conduct this analysis for special categories of 4-digit products that group products with similar factor intensity (primary products; natural-resource intensive products; unskilled-labour intensive products; technology intensive products; human-capital intensive products). For this we use the HvM classification described above.

Before we proceed with a more formal analysis of specialisation dynamics it is worth discussing some broad properties of the data we are working with. Interestingly, the majority of exports occur within relatively few 4-digit product categories with RCA index values above 1 (Figure 3.1) and this does not seem to have changed much since the beginning of 1990s. For some OECD and SEM economies this share exceeds 80% and it is above 60% for all countries in the sample. At the same time, 4-digit product lines with RCA index values above 1 typically account for around 30% of all product lines (Figure 3.6). Overall, the RCA index performs rather well in identifying the minority of products that account for the bulk of country's exports. Such a property would be expected of an index constructed to identify internationally traded products where a country has a relative cost advantage, especially when one accepts the many sources of comparative advantage identified in the literature. Cross-country differences suggest, however, that in some countries, many of which are the most economically advanced OECD members, up to 30% of exports occur in product categories with revealed comparative disadvantage. At the same time the share of 4-digit products with revealed comparative advantage tends to be higher in the OECD grouping.[23]

As foreshadowed above, an increase in the RCA index may reflect: (i) a situation where an increase in country's share of the world market for a particular product exceeds the increase in country's overall share in world exports (Category 1 in Figure 3.3); (ii) a situation where a decrease in country's share in market for a particular product is less severe than the decrease in country's overall share in world exports (Category 2); or (iii) a situation where market share is gained in a particular product while a country's overall share in world exports is decreasing (Category 3). In our dataset in SEM countries increases of RCA indices in 4-digit product categories tend to be concentrated in Category 1 while in the OECD countries they tend to be concentrated in Category 3 (Figure 3.3).

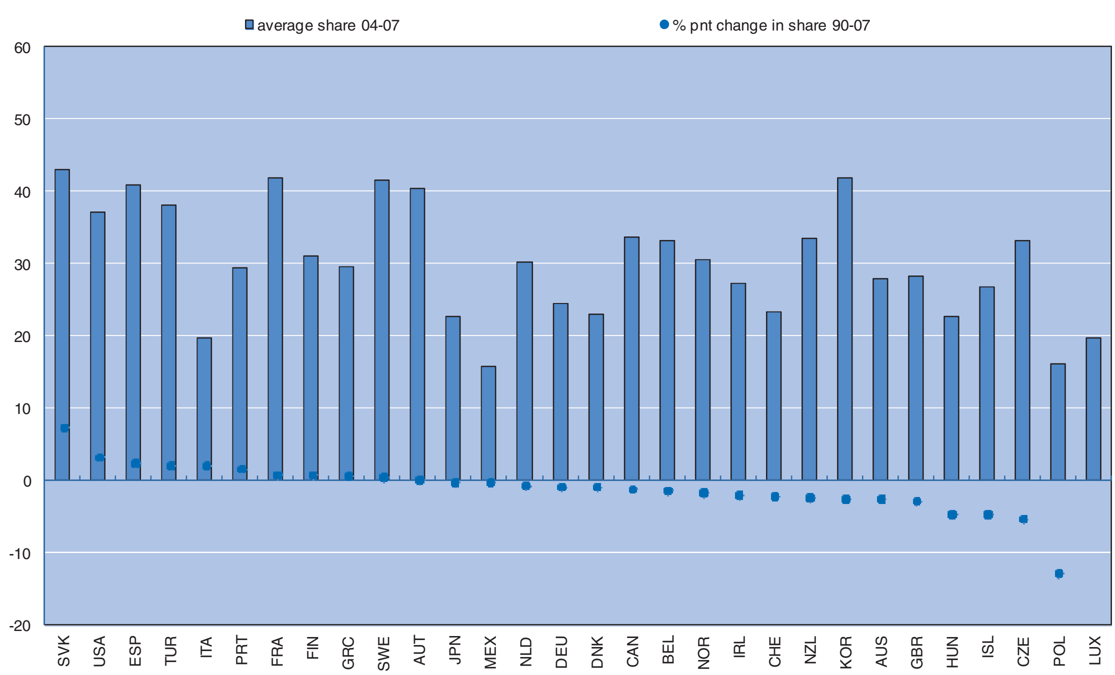
Figure 3.1. Share of exports in 4-digit product categories with RCA index>1



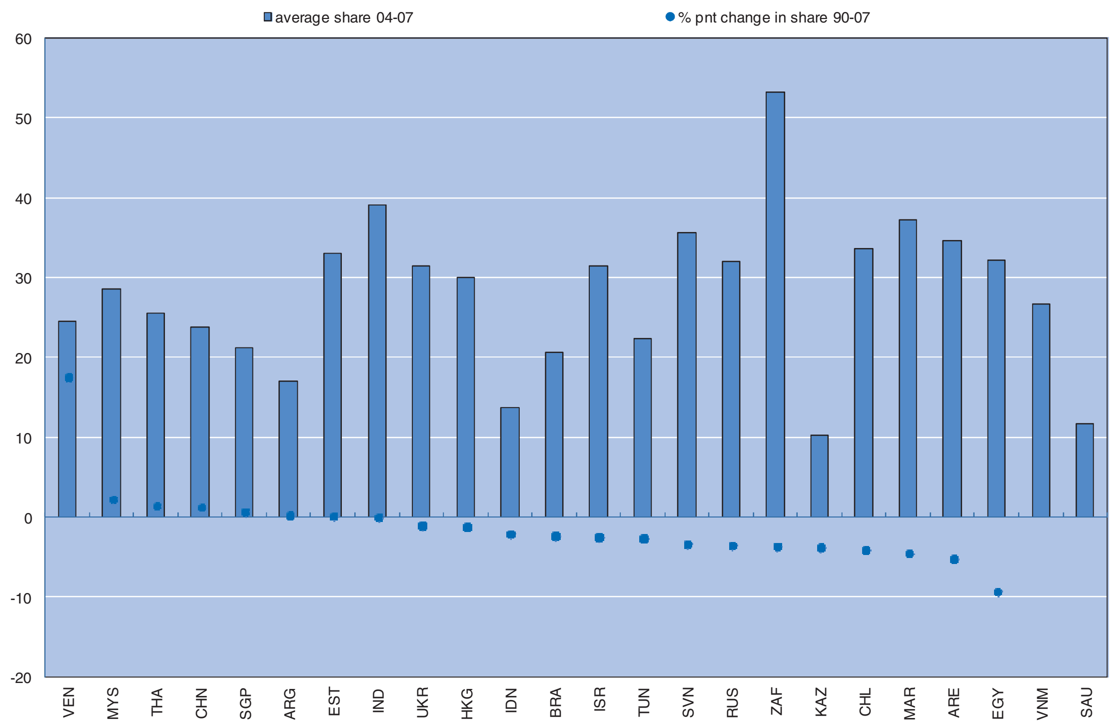
Source: Data from UN ComTrade, authors' calculations.

Figure 3.2. Share of traded 4-digit product categories with an RCA index >1

Panel A. OECD

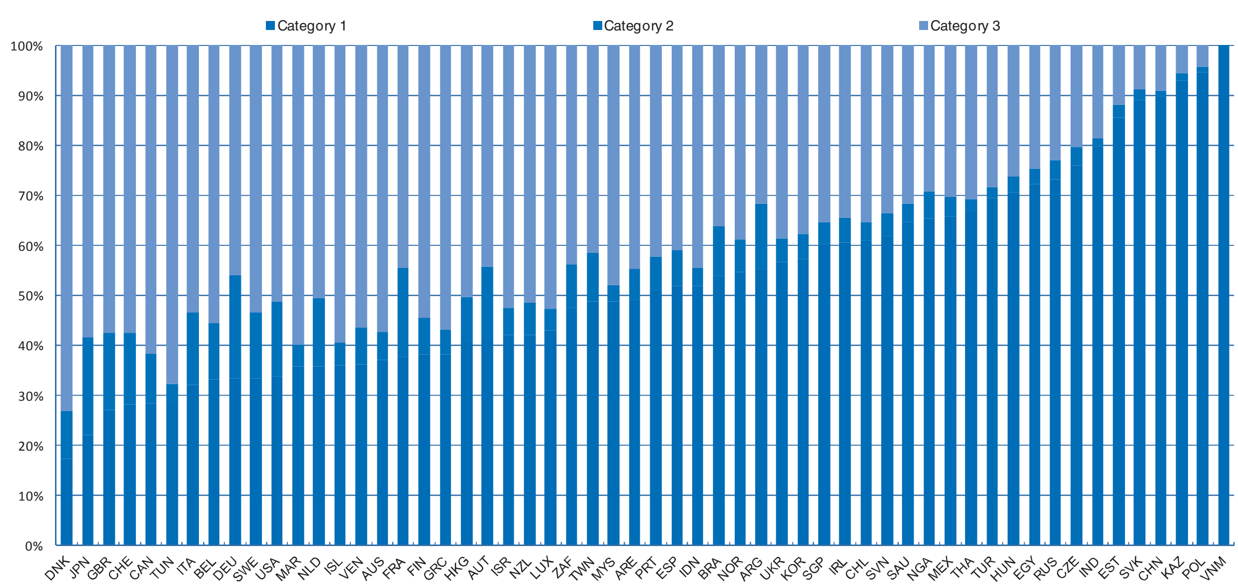


Panel B. Selected emerging market economies



Source: Data from UN ComTrade, authors' calculations.

Figure 3.3. Determinants of increases in RCA indices



Source: Data from UN ComTrade, authors' calculations.

Shape of RCA index distribution

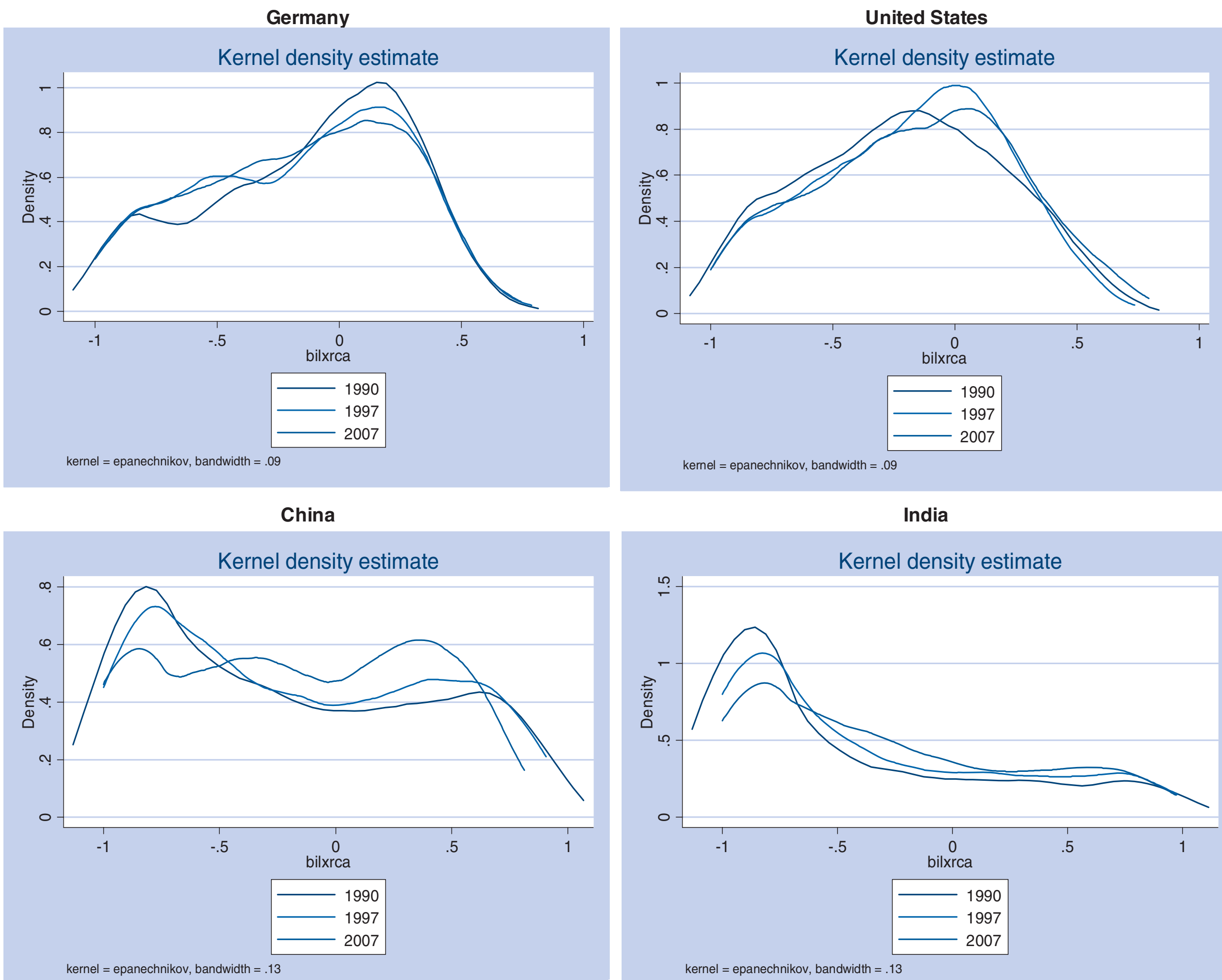
To investigate the evolution of specialisation patterns at the product line level we estimate density functions of RCA distributions[24] for each country and year. For purely presentational purposes these density functions are estimated for a symmetric transformation of the original RCA index (Dalaum *et al*., 1998 and Laursen, 2000) where values above 0, instead of 1, indicate products in which a country is deemed to have revealed comparative advantage.[25] The estimated density functions provide information on cross-country differences in the evolution of RCA distribution across the product space.

To give an example of some of the stark differences in initial RCA distributions and their evolution, Figure 3.4 below presents estimated RCA density functions for the United States, Germany, China and India. Initial distributions (year 1990) for China and India are skewed in the direction of low values of the index indicating a high incidence of product lines with a revealed comparative disadvantage. Initial distributions for Germany and the United States, while generally less skewed than those for China or India, are skewed in the direction of higher values of the RCA index, indicating relatively higher incidence of products with a revealed comparative advantage (this can also be seen in Figure 3.2, Panel A and B). Dispersion of RCA values, measured by the coefficient of variation,[26] also differs across these countries with distributions for Germany and the United States being less dispersed than those for China and India (coefficients of variation in 1990 of, respectively, 0.8, 1.0, 1.8 and 3.5).

A tendency can be observed in OECD countries for dispersion of RCAs to fall in time, but this is not the case for the SEM economies. This could reflect a negative relationship between the level of economic development and polarisation of export specialisation where countries at lower levels of development tend to export many products with either high or low revealed comparative advantage while richer economies have both higher shares of products with revealed comparative advantage and tend to export more products with moderate revealed comparative advantage. This can be illustrated with the examples of China and the United States in Figure 3.4 where in 2007 China's distribution reflected a high density of products with revealed comparative advantage as well as a high density of products with revealed comparative disadvantage. In the United States the highest incidence was concentrated around values indicating moderate revealed comparative advantage.[27] This provides some additional support for the literature investigating the links between the level of economic development and concentration of employment (Imbs and Wacziarg, 2003) or economic development and export diversification (Carrere *et al*., 2007).

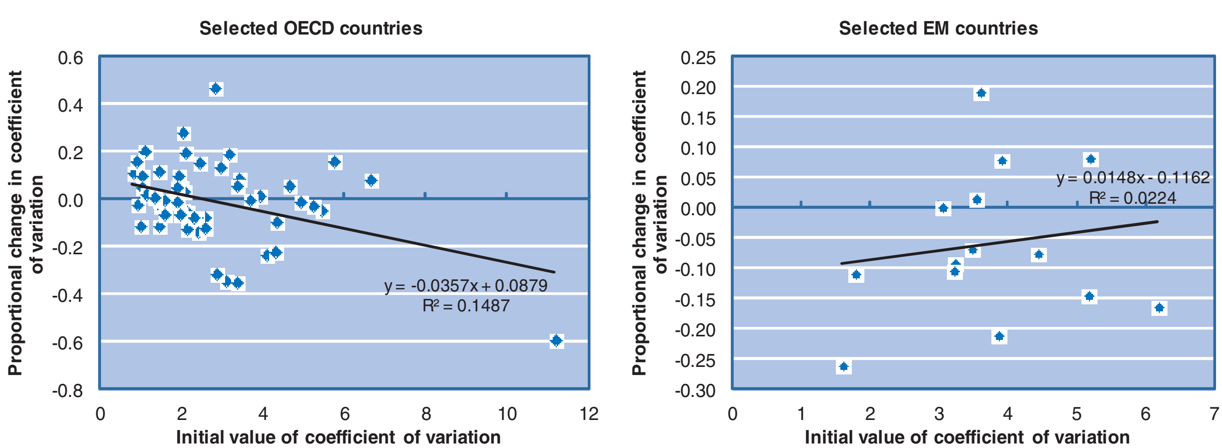
Imbs and Wacziarg (2003) show that along the process of economic development economic activity is first spread more equally across sectors and then relatively late in the development process concentrates in a narrower set of activities. Carrere *et al.* (2007) find a hump-shaped pattern of export diversification; "low and middle income countries diversify mostly along the extensive margin whereas high income countries diversify along the intensive margin and ultimately re-concentrate their exports towards fewer products." In our data OECD countries with initially high coefficients of variation in RCA indices experience the largest reductions (Figure 3.5) and this relationship is statistically significant.[28] Optically, we observe a reversed tendency for selected SEM economies where large initial coefficients seem to experience larger increases, although the relationship is based on fewer data points as compared to the OECD grouping and is not statistically significant.

Figure 3.4. Kernel density estimates for Germany, United States, China and India in 1990, 1997 and 2007



Source: Data from UN ComTrade, authors' calculations.

Figure 3.5. Dispersion in RCA indices



Source: Data from UN ComTrade, authors' calculations.

There are also marked differences in the time evolution of external shapes of RCA distributions in Figure 3.8. The most dramatic visual changes can be observed for China where the left-hand-side hump indicating high density of products with comparative disadvantage levels off gradually, while another hump emerges on the right hand side of the distribution indicating higher incidence of products with comparative advantage. In the case of India the left-hand-side hump levels off yet more pronouncedly and more products move to the comparative advantage range. Yet, they do not concentrate around any particular RCA value indicating a wider range of degrees of comparative advantage as compared to China. In the case of the United States, the RCA distribution gradually becomes more skewed and concentrated in the territory of moderate revealed comparative advantage. In Germany, an opposite process can be observed with decreasing concentration of products around moderate comparative advantage and increasing incidence of products with comparative disadvantage of various degrees.

Intra-distributional mobility

Exports and imports of specific goods change over time as a response to various economic incentives and so does the ordering of comparative advantage indices. To formally study mobility (or persistence) of specialisation we need to jointly consider the overall distribution of the RCA index and the intra-distributional mobility of individual products. This is done by calculating the so-called transition matrices which summarise information on probability of transition of a given product from one specified interval of RCA values to another (see Proudman and Redding, 2000). We chose the intervals to be the deciles[29] of the RCA distribution containing all product-year observations; these are the RCA intervals that contained one tenth of all 4-digit product-year observations, sorted by values of the RCA index. From a transition matrix we can gauge the probability of a given product that was initially in the *k-th* decile of the RCA distribution of moving to the *l-th* decile in an average year during the 1990-2007 period. So, for example, a 5% probability of transition between the first and the tenth decile means that, a randomly selected product that happened to be in the lowest decile of RCA distribution (i.e. within the range of RCA values containing 10% of products with lowest RCA values) has a 5% chance of ending up in the highest decile (i.e. within the range of RCA values containing 10% of products with highest RCA values). Usually products with revealed comparative advantage (RCA>1) tend to be located in the top three to four deciles of the RCA distribution.

Table 3.3 presents such transition matrices for the United States, Germany, China and India for average annual transition during the 1990-2007 period. Highest values are concentrated around the diagonal of the matrix indicating high probability of products of either staying in the same decile or moving up or down to the neighbouring deciles, but not to too far located deciles. Values reported on diagonals indicate the probabilities of products persisting in the same decile. These diagonal values suggest that, for example, the degree of mobility of products is higher in India than it is in the United States. This is expected as India is a developing economy undergoing a considerable economic transition. The differences are particularly stark for the lowest deciles; for example, in the United States there is an over 85% probability of a product starting and ending up in the lowest decile while in India this probability is 63%. Yet, the probability of starting and ending up in the highest decile is approximately equal in the two countries. A comparison between the United States and China, or between Germany and China, yield much less expected results. Namely, we observe only a marginally higher degree of mobility in China, mainly as far as transition out of the lowest deciles is concerned.

It is possible to reduce the information contained in the transition matrix to a single statistic that evaluates the overall degree of mobility and allows cross country comparisons. The first such mobility index (M1) developed by Shorrocks (1978) (see Annex 3.B) and considered here summarises the information contained in the matrix's diagonal for each country in the sample (Panel A in Figure 3.6). High values of M1 indicate mobility while low values of M1 indicate persistence in specialisation patterns. The second index (M2) developed by Bartholomew (1973) summarises information on the average number of deciles crossed by a product originally in decile *k* weighted by unconditional probabilities of a product being in a particular decile in a stationary RCA distribution towards which patterns of international specialisation are evolving in the long term (i.e. the so-called ergodic distribution). M2 is presented in Panel B of Figure 3.6. As in the case of M1 high values of M2 imply high mobility.

It is not surprising to see that, despite certain differences in rankings, both these indices suggest relatively higher specialisation mobility in SEM economies as compared to the majority of OECD countries. Yet, there are a number of noteworthy exceptions to this rule. One exception group is composed of transition countries such as Estonia, Hungary, Poland or the Czech Republic. Other OECD countries with high mobility indices include Iceland, Greece, Ireland, Australia and New Zealand where the higher mobility is primarily driven by high upward mobility of primary products. Lowest mobility indices are calculated for some of the most well-off and largest OECD economies. For example the G3 countries (Germany, Japan and the United States) record some of the lowest values of mobility indices (Figure 3.6). Consistent with the information presented in Table 3.3, but contrary to anecdotal evidence, China displays much lower mobility compared to other SEMs, suggesting that its export specialisation structure evolved mush less than in SEMs, for example Indonesia, India or, to a lesser extent, Brazil.

Economic theory suggests that high mobility can be explained by: (i) rapid factor accumulation especially if it leads to a change in country's relative factor abundance; (ii) endogenous technological change, knowledge spillovers or technology transfer; (iii) processes associated with geographical agglomeration or dispersion of economic activity. Second, changes in demand patterns can also result in changing specialisation. Third, there is ample evidence that comparative advantage can be influenced by targeted policies (e.g. direct and indirect subsidies, trade protection, industrial policy) as well as horizontal polices (e.g. labour and capital market policies, quality of law, exchange rate, etc.). Comparative advantage of a country may also be influenced indirectly by all the above developments in its trading partners.

Table 3.3. Transition matrices, United States, Germany, China and India average annual change, 1990-2007

United States

Starting interval	End interval 1	2	3	4	5	6	7	8	9	10
1	85.45	11.88	1.50	0.32	0.24	0.28	0.12	0.00	0.08	0.12
2	11.44	69.19	15.47	2.24	0.65	0.41	0.16	0.24	0.12	0.08
3	1.82	14.76	60.62	18.00	2.88	1.01	0.36	0.32	0.08	0.12
4	0.41	2.28	17.37	56.27	18.27	3.50	1.14	0.41	0.24	0.12
5	0.20	0.65	2.97	17.56	53.41	19.67	3.54	1.22	0.45	0.33
6	0.20	0.37	1.18	3.53	19.81	50.77	18.75	3.77	1.26	0.37
7	0.16	0.28	0.53	1.10	3.13	19.03	53.17	19.24	2.60	0.77
8	0.00	0.24	0.20	0.45	0.93	3.78	19.37	56.68	16.48	1.87
9	0.12	0.16	0.24	0.24	0.49	1.22	2.52	16.69	66.53	11.78
10	0.08	0.16	0.08	0.16	0.16	0.41	0.90	1.47	12.23	84.34

Germany

Starting interval	End interval 1	2	3	4	5	6	7	8	9	10
1	87.42	10.92	0.70	0.50	0.21	0.08	0.04	0.00	0.00	0.12
2	11.20	71.39	15.24	1.51	0.20	0.08	0.20	0.12	0.04	0.00
3	0.57	15.58	65.93	15.79	1.35	0.37	0.20	0.12	0.04	0.04
4	0.16	1.51	15.83	62.68	16.86	1.80	0.57	0.16	0.20	0.20
5	0.16	0.37	1.55	16.81	60.57	17.06	2.62	0.61	0.12	0.12
6	0.12	0.12	0.33	1.75	17.77	59.13	18.46	1.75	0.41	0.16
7	0.12	0.04	0.29	0.45	2.57	18.60	58.73	17.29	1.67	0.24
8	0.04	0.12	0.00	0.25	0.25	2.38	17.58	61.39	16.97	1.02
9	0.08	0.04	0.08	0.24	0.04	0.49	1.18	17.01	69.62	11.22
10	0.04	0.04	0.00	0.12	0.08	0.08	0.41	1.48	10.95	86.80

China

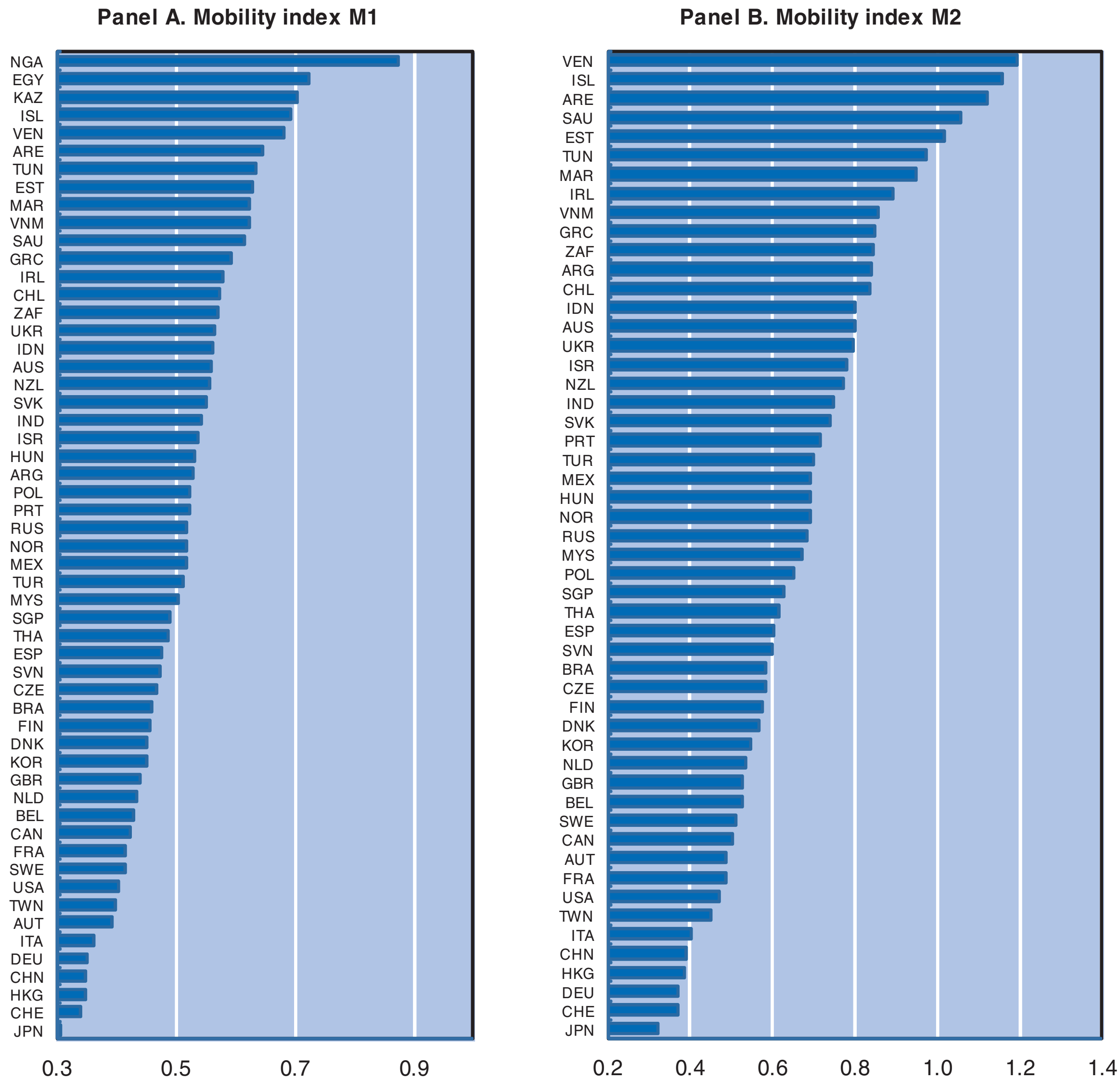
Starting interval	End interval 1	2	3	4	5	6	7	8	9	10
1	82.64	13.36	2.11	0.97	0.34	0.21	0.08	0.25	0.04	0.00
2	12.68	66.54	15.35	3.37	1.31	0.49	0.16	0.04	0.00	0.04
3	2.21	15.47	61.21	16.49	3.03	1.02	0.37	0.12	0.08	0.00
4	1.07	3.24	16.62	57.90	17.93	2.01	0.94	0.21	0.04	0.04
5	0.45	0.98	3.12	17.10	58.14	17.10	2.30	0.62	0.21	0.00
6	0.16	0.33	0.94	2.66	16.17	61.81	16.13	1.43	0.33	0.04
7	0.08	0.25	0.45	1.19	2.25	15.16	64.06	14.75	1.43	0.37
8	0.16	0.08	0.12	0.12	0.49	1.64	14.05	68.55	14.05	0.74
9	0.04	0.08	0.08	0.16	0.12	0.53	1.68	13.26	74.95	9.09
10	0.04	0.04	0.00	0.00	0.16	0.12	0.16	0.74	8.94	89.78

India

Starting interval	End interval 1	2	3	4	5	6	7	8	9	10
1	63.21	21.59	6.72	3.01	2.22	1.39	0.74	0.51	0.56	0.05
2	19.87	44.51	21.23	7.18	3.15	1.53	1.05	0.74	0.53	0.22
3	5.15	21.80	38.49	21.63	7.66	2.21	1.30	1.08	0.39	0.30
4	2.89	6.08	21.70	37.96	20.15	6.90	2.59	0.95	0.52	0.26
5	1.51	3.36	7.62	20.23	37.37	20.40	6.67	2.02	0.73	0.09
6	0.86	1.20	2.96	5.97	20.52	41.65	19.88	5.50	1.07	0.39
7	1.03	0.82	1.07	3.05	6.66	21.12	45.00	17.48	3.01	0.77
8	0.39	0.34	0.64	0.99	1.93	4.16	19.24	53.63	16.62	2.06
9	0.13	0.21	0.39	0.34	0.77	1.29	3.43	17.27	64.51	11.66
10	0.00	0.09	0.04	0.09	0.09	0.26	0.69	1.38	12.73	84.65

Source: Data from UN ComTrade, authors' calculations.

Figure 3.6. Mobility indices, all product categories



Source: Data from UN ComTrade, authors' calculations.

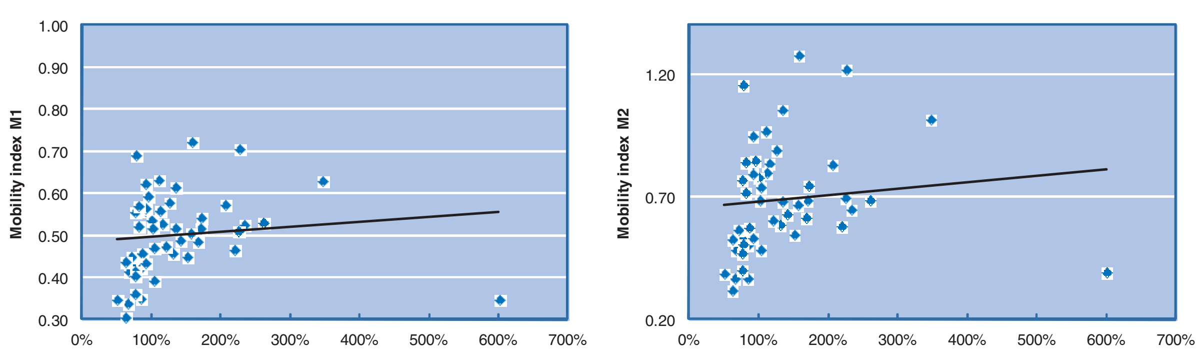
Some of these factors are common across the OECD and SEM country groupings, but some are likely country, country group or region-specific. Relative price adjustments associated with integration with world markets, pace of capital accumulation (through FDI and domestic investment), innovation and technology adoption as well agglomeration processes has been argued to have been more prominent in the SEM grouping as several of these economies have transited from either centrally planned or severely distorted economies to ones that compete in world markets. Therefore, it can be argued, their economic structures have been undergoing a process of significant adjustment to world market conditions. In richer and more mature OECD economies these processes would be expected to be less prominent, though some adjustment would definitely be expected given the profound change in available relative factor endowments (particularly labour relative to other factors) associated with the increased integration with the world economy of some emerging economies such as Brazil, Russia, India or

China (OECD, 2009). Yet, while this shock was significant, by the sheer comparison of economic sizes, it was likely more significant for the concerned SEMs which were integrating with much larger and advanced trading partners.[30] This is likely reflected in relatively higher specialisation mobility estimated for the SEM economies and certain transition OECD members.

The relatively low mobility indices calculated for China might reflect such a 'size effect' where the large size of China's economy may have resulted in a lesser structural change following integration with world markets than would have been the case with a smaller emerging economy. The low mobility result for China suggests that China's unprecedented trade expansion has not been driven so much by changes in specialisation patterns but rather by a general increase in exported volumes across many products. Such a finding is consistent with some evidence obtained from different analytical approach by Gilbert (2011). Gilbert employed decomposed changes in world trade flows into: (i) world growth effects; (ii) commodity effects; (iii) market effects; and (iv) competitiveness effects. This approach, called constant market shares analysis, produced an interesting finding that China's trade expansion has been driven predominantly by the competitiveness effect, which is consistent with the low mobility indices obtained for China in our analysis.

Can we say something more specific about these mobility trends? Should mobility of specialisation in itself be interpreted as a positive state of affairs? This can certainly vary from case to case, especially if shorter time periods are concerned. Examples can be given of economic or political events that could result in both high mobility of the specialisation pattern and at the same time be welfare or income reducing or increasing. It is less probable that high mobility measured over longer time period would be associated with negative economic outcomes though such a case should not be excluded, for example, in cases where mobility would be triggered by unpredictable and highly volatile demand or supply conditions. In normal market conditions free choice and profit seeking of economic agents would be expected to support a positive relationship between mobility and economic outcomes measured with conventional indicators, for example value added. In this context, it is interesting to observe a rather strong positive correlation of mobility indices M1 and M2 with gains in world markets shares (Figure 3.7); countries with highest mobility indices have been gaining shares of world goods markets more rapidly than countries with more persistent specialisation patterns. China is again an outlier in the figure with exceptionally high trade share gains given the low estimated mobility of its export specialisation.

Figure 3.7. Correlation of mobility indices with world trade share developments

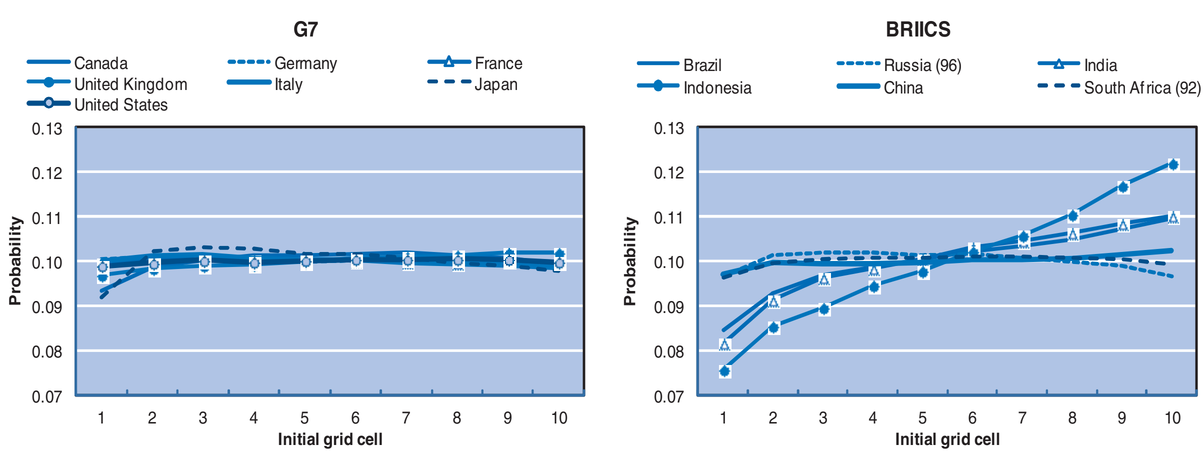


Source: Data from UN ComTrade, authors' calculations.

High mobility may be indicative of products going up or down the export specialisation ranking so it is interesting to consider the direction of changes as well. This question can be addressed with the use of the so-called *ergodic distributions* of RCA indices. The ergodic distribution can be interpreted as a limiting stationary RCA distribution to which patterns of specialisation of a country would converge if the dynamics captured in transition matrices (as in Table 3, for instance) went on indefinitely. It is the unconditional probability of a randomly chosen product being in a particular decile of RCA distribution in the limit (Proudman and Redding, 2000).

Ergodic distributions presented in Figure 3.8 show remarkable discrepancies in the degree and direction of export specialisation patterns between the G7 and BRIICS groupings. First, for the G7 countries probabilities are typically concentrated around the 0.1 value which means that the distribution of RCA has not changed much during the 1990-2007 period.[31] A randomly chosen 4-digit product has an approximately 10% probability of falling into any decile grid cell (left panel in Figure 3.8), so the long-term distribution is not much different from the initial one. This can be contrasted with results for the BRIICS countries (right panel in Figure 3.8). In Indonesia, for example, a randomly chosen product has around 4% probability of falling into the lowest decile and above 16% probability of falling into the highest decile. This means that the Indonesia's RCA density function is shifting in the direction of higher values of RCA and the analysis presented in the next section indicates that this was driven by primary and unskilled labour-intensive products. In all BRIICS countries, apart from South Africa, lines in Figure 3.8 are upward sloping indicating that RCA distributions are shifting to the right.

Figure 3.8. Ergodic distributions, G7 and BRIICS, 1990-2007



Source: Data from UN ComTrade, authors' calculations.

Dynamics of specialisation by intensity of factor use

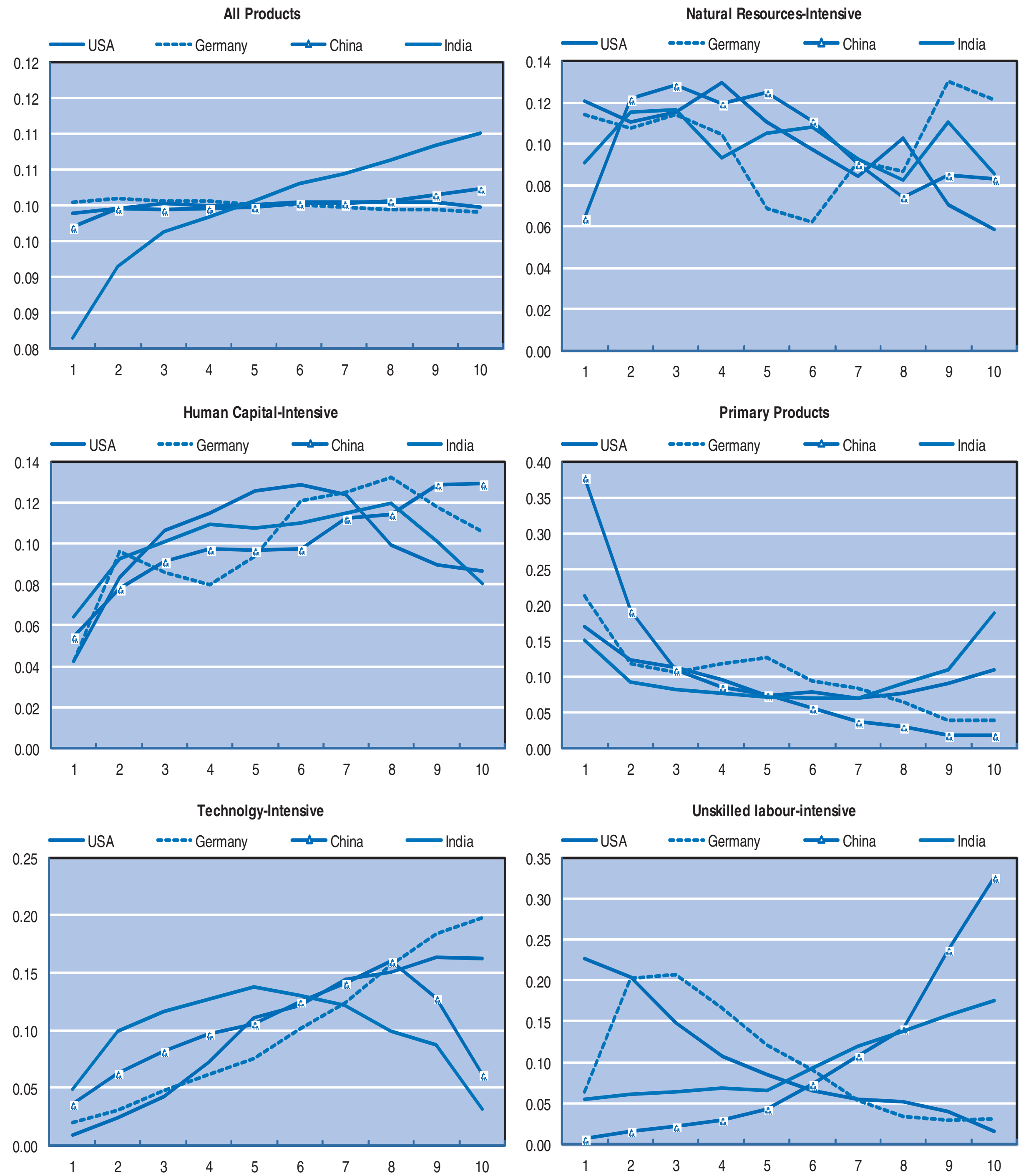
The above results seem to confirm the earlier result about the overall higher degree of mobility of export specialisation in the SEM grouping, though with some notable exceptions. Yet, this conclusion becomes less firm when we consider product groupings based on intensity of factor use. Figure 3.9 presents ergodic distributions for these product groupings for the United States, Germany, China and India. First, we observe that the "all products" category masks important and meaningful heterogeneity of dynamics in product groupings. For example, for human capital-intensive or technology-intensive products there is a more or less common tendency for the four countries' RCA distributions to be shifting toward higher RCA values while an opposite tendency can be observed for primary and natural resource-intensive products. If we aggregated these two product groupings together we could have obtained relatively flat ergodic distributions masking considerable dynamics in opposite direction. This seems to be the case in China where the ergodic distribution for all products is relatively flat, while those for primary and unskilled labour-intensive products, for example, have very steep slopes, albeit in opposite directions.

RCA distributions for human-capital-intensive and technology-intensive products are shifting to the right in the United States, Germany and China, albeit more so in the case of technology intensive products, suggesting an evolution in the direction of increasing revealed comparative advantage in these product categories. This means that China, while being relatively unskilled labour-abundant, is expanding its comparative advantage in these more advanced product categories. Most dramatic evolution can be seen in primary products where the RCA distributions are shifting towards lowest values of RCA suggesting an increasing comparative disadvantage with the exception of India where the U-shaped ergodic distribution suggest an evolution in the direction of a more polarised RCA distribution.

Unskilled labour-intensive products are perhaps the most interesting case with a high degree of mobility of RCA distributions and vividly opposing directions of these changes when OECD countries are compared with SEMs. In China, for example, there is a close to zero probability of unskilled labour-intensive products of falling into the lowest decile and close to 35% probability of falling into the highest decile. In contrast, in the United States there is a close to zero probability of such products to fall into the highest decile and there is a close to 25% probability of falling into the lowest decile. There is a similar contrast between the Indian and German cases though differences are smaller. This means that in the last two decades United States and Germany have been progressively losing revealed comparative advantage in unskilled-labour intensive products while countries such as China or India have been expanding their advantage in these kinds of products. Equivalent calculations performed for other countries suggest that this dichotomy generalises, with some exceptions, to other countries in the OECD and SEM groupings.[32]

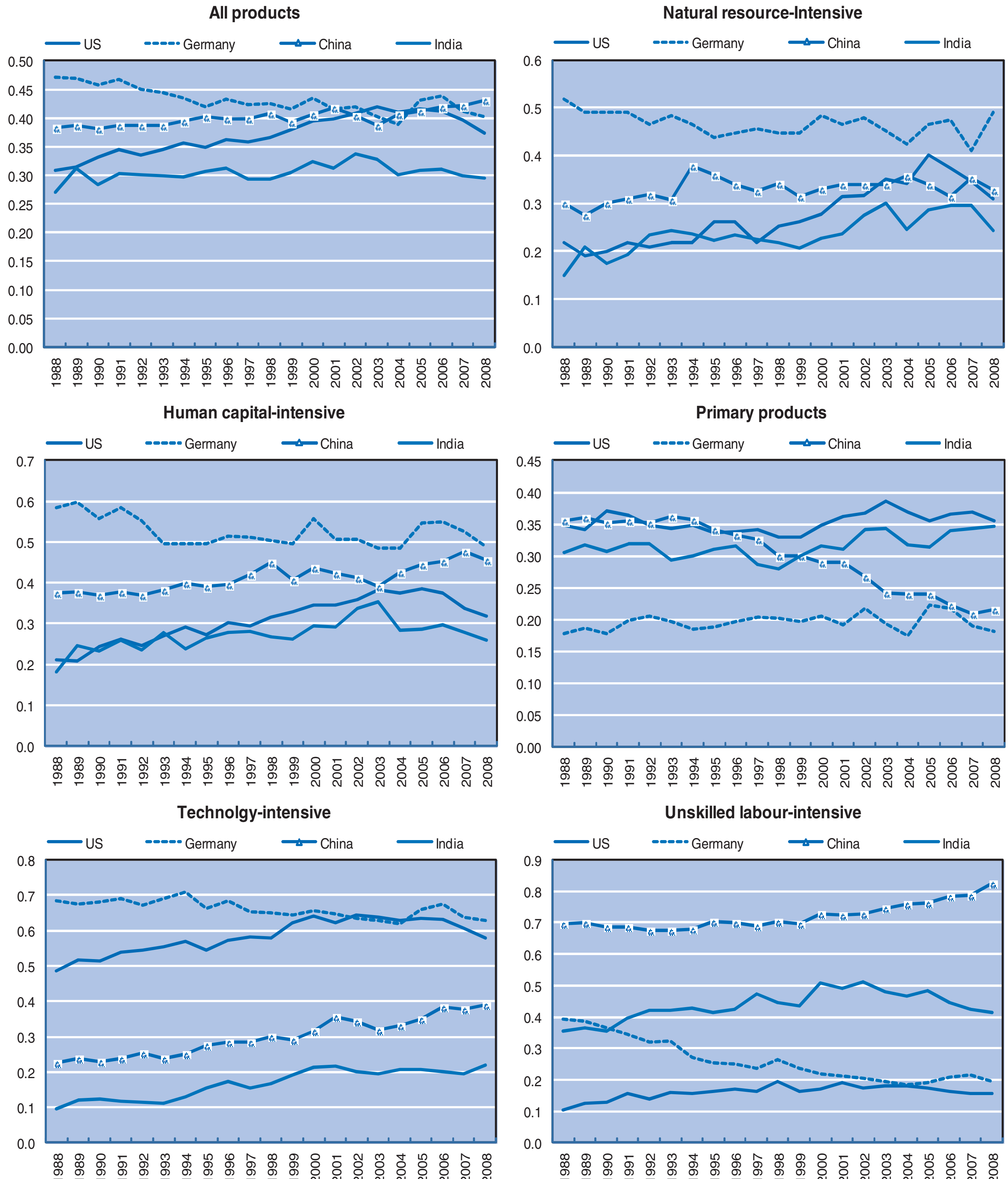
The lack of such starkly opposing trends in the case of technology and human-capital intensive products suggests that most of the structural adjustment associated with the integration of SEM economies with the world economy may have been borne by unskilled labour-intensive sectors. Moreover, data suggests that these trends are not easing up (Figure 3.10). China has had revealed comparative advantage in over 70% of unskilled labour-intensive products at the beginning of the 1990s and this share has been climbing steadily over the 1988-2008 period, while in Germany, for example, this share has been gradually declining. This is consistent with the hypothesis that the integration of some of the SEMs with the world economy was a significant shock to world relative factor endowments, particularly for unskilled labour. Trade and FDI are the channels through which the effects of some of the factor differentials are being transmitted. These results suggest also that mobility of factors may be of key importance. It is a well established fact that unskilled labour is less mobile both within and across countries while technology and human capital can travel more easily across countries (e.g. through FDI). Higher mobility of technology and skilled-labour likely could explain the disparities in the evolution of specialisation in unskilled labour-intensive products and similarities the evolution of human capital-intensive and technology-intensive products.

Figure 3.9. Ergodic distributions for the United States, Germany, China and India 1990-2008, by factor intensity



Source: Data from UN ComTrade, authors' calculations.

Figure 3.10. Share of products with RCA index above 1 by factor intensity



Source: Data from UN ComTrade, authors' calculations.

Conclusions

Empirical analysis presented in this chapter has several implications for the debate on the effects of globalisation. The finding of lower mobility of export specialisation in OECD economies as compared to SEM economies suggests that, with some exceptions, the globalisation era has been associated with a higher degree of adjustment in trade structures among emerging economies. One straightforward explanation of this is that relative price adjustments associated with reintegration with world markets, pace of capital accumulation (through FDI and domestic investment), innovation and technology adoption as well agglomeration processes can be argued to have been more prominent in the SEM grouping as several of these economies have evolved from either centrally planned or severely distorted economies to ones that compete successfully in world markets. Owing to the higher degree of integration with world markets and to their size, the majority of the OECD economies would be expected to be less affected by this process, though some adjustment would definitely be likely given the profound change in relative factor endowments, particularly in relation to labour, implied by the increased integration of some SEMs with the world economy.

This interpretation is further supported by evidence of differences in mobility of export specialisation across products classified according to factor intensity. Our results show that in the last two decades many richer OECD countries have been progressively losing revealed comparative advantage in unskilled-labour intensive products while SEM countries such as China or India have been expanding their advantage in this kind of products. The lack of such starkly opposing trends in the case of technology and human-capital intensive products, where both the OECD and some more advanced SEM economies are developing comparative advantage, provides further, albeit admittedly indirect, support to the hypothesis that most of the structural adjustment associated with increased integration of SEM economies with the world economy may have indeed been borne by unskilled labour. These findings are consistent with the fact that unskilled labour belongs to the least mobile factors both within and across countries, while technology and human capital can move more easily.

Our findings would also lend support to the view expressed by Bhagwati (2007) that, contrary to the claim by Friedman (2005), the "earth is not flat" and that that the notion of comparative advantage remains relevant for policy making. We would argue that this is especially true when it is acknowledged that comparative advantage is not static. On the other hand, our results pertaining to specialisation trends in unskilled-labour intensive products, would call for some caution with respect to what Bhagwati (2007) calls the "human face of globalisation." The implication would not be to reverse the open trade regime that has unleashed the comparative advantage forces and contributed to the prosperity of OECD and SEM countries for so long, but rather to consider how the gains from trade can be spread more widely, so that trade and investment liberalisation is supported equally by businesses and by workers.

Notes

1. Przemyslaw Kowalski, Trade Policy Analyst, Trade and Agriculture Directorate, OECD, and Novella Bottini, Università Cattaneo, LIUC. The authors would like to thank Clarisse Legendre for excellent statistical assistance and the OECD Working Party of the Trade Committee for providing direction and comments. Material presented in this chapter benefited from comments and guidance of the Working Party of the OECD Trade Committee, participants to the OECD Global Forum on Trade in Chengdu, China as well as an internal OECD workshop with participation of representatives from Brazil, China, India, Indonesia and South Africa.

2. In Porter's mind governments should aim at maximising productivity in selected sector, through enhancement of cost based advantages (infrastructure, human capital development, institutions) as well as product-based advantages (emphasis on innovation and the development of differentiated products with high technology content), with the emphasis on the latter. Warr (1994) pointed out that the comparative advantage proposition had been never intended to explain the main determinants of economic performance but was meant to deal with principles that should guide an efficient allocation of resources. Warr (1994) argued also that the analogy between firms and nations was incorrect since firms typically face smaller differences in costs as compared to nations and have very different objectives. Davies and Ellis (2000) deemed that the theory developed a useful taxonomy for SWOT-type analysis of economies' positions with respect to the competitiveness of different industrial sectors, but it did not develop guidelines with respect to appropriate national policies to pursue (Davies and Ellis, 2000).

3. Krueger provided an exhaustive list of circumstances and other premises which, combined with the comparative advantage driven specialisation in primary products, led analysts to prescription of protectionist policies of the import substitution era. These included the initial specialisation of underdeveloped countries in primary commodities, the observation that this specialisation correlated at the time with low living standards, the hypothesis that income and price elasticities of demand for primary commodities were low ("export pessimism"), high incidence of unemployment and its interpretation as evidence for surplus labour, the belief that capital accumulation through importation of capital goods was crucial for growth, the premise that there was very little response to price incentives in developing countries and the infant industry argument.

4. See note 3 for the list of all analytical elements that led to prescription of import substitution policies.

5. The inquiry by the World Bank considered Hong Kong, Indonesia, Japan, Korea, Malaysia, Singapore, Taiwan and Thailand (Barnes *et al*., 2003)

6. Rodrik (2009) basically argues that the case for policy intervention in the development of the tradable sector is as strong as in areas such as for example education or environmental policies. Yet, it can be argued that industrial policy and correcting market imperfections should not be seen as interchangeable concepts. Some motivation behind industrial policy may be market imperfections but industrial policy could be distinguished as associated with targeting a sector, while improving market imperfections could be associated with improving market signals across sectors.

7. Kiyota (2008) is an attempt at such a study based on Japan's experience.

8. Balassa (1965) wrote: "In the absence of appropriate data on production costs in the manufacturing industries of individual countries, it may be proposed to rely on prevailing theories of international specialisation for determining the pattern of comparative advantage. Among these doctrines, the Heckscher-Ohlin theory and the classical theory of comparative advantage can claim our attention".

9. Balassa did not explicitly call his index of export specialisation an index of revealed comparative advantage but such a term appeared in the title of his paper (Balassa, 1965) and was later incorporated into the name of the index in the literature that referred to Balassa's work.

10. An example of the cardinal interpretation of values of the RCA is that a country that accounts for 10% of total world manufacturing exports would record an RCA of 2 for product A if its exports account for 20% of world exports of A, while it would record an RCA of 4 in product B if its exports account for 40% of world exports of B. Alternatively, considering a product that accounts for 10% of world manufacturing exports, twice as large a share of country X in world exports of this product compared to country Y (e.g. 40% compared to 20%), would be reflected in twice as large a value of RCA index (in this case RCA of 4 for X compared to RCA of 2 for Y).

11. For example, the goals of India's New Foreign Trade Policy 2004-2009 were to double India's percentage share of global merchandise trade within the five years, increasing India's share in world trade from 0.8% to 1.5% by 2009.

12. It is possible for an RCA index to increase when a commercial 'failure' of a particular product category being less severe than the commercial 'failure' of a country as a whole.

13. This means that an increase in an RCA calculated for a particular product must be associated with a decrease of an RCA for at least one other product, revealing a property that would be expected of an index of export specialisation. The total weighted share of a country's exports must equal its share of world exports – so a country could be expanding is several areas as long as it was increasing its share of overall trade.

14. A condition for the RCA index to correspond to the difference between autarchic and free trade relative prices, i.e. a condition under which a cross country comparison of RCA indices has a direct correspondence to a cross country correspondence of pre-trade relative prices, has been derived by Hillman (1980). He also showed that there is not such a correspondence for cross-industry comparison.

15. Selected emerging market (SEM) economies country grouping varies depending on data availability (in some years at the beginning of the 1990-2007 period data for certain countries is missing) but it intends to cover all the OECD Enhanced Engagement (EE) countries (Brazil, India, Indonesia, China and South Africa), Russia (which has the status of an accession country in the OECD) as well as other major emerging economies such as Argentina, Hong Kong, China, Chinese Taipei, Thailand, Singapore, Morocco, Tunisia.

16. This data was provided by the Structural Economic Statistics Division of the Statistics Directorate.

17. This classification is based on UNCTAD / WTO / ITC classification using the SITC rev 3 codes and is available at *www2.econ.uu.nl/users/marrewijk/eta/intensity.htm*.

18. Coefficient of variation is defined here as a ratio of standard deviation and average.

19. Certainly, analysis at such a high level of product aggregation masks some of the changes within product categories. For instance, electronic products produced in 2007 in any country are much different from electronics produced in 1993, especially in countries that are keeping up with technological developments.

20. When we compare 1993 and 2007 we observe more changes in countries for which we have data but for some countries such a comparison is not possible.

21. Formal testing would involve characterising the density function of the RCA index and, as shown further down, there are considerable differences in empirical RCA distributions across countries and which evolve over time.

22. These standard deviations are 3.0, 2.6 and 2.0 for 1993, 2000 and 2007, respectively.

23. By construction of the RCA index this statistic will always be above 50% but a higher percentage means that the country relies for export revenue more on products in which it has revealed comparative advantage. Significant reliance on exports of product with comparative disadvantage (low percentage of exports in products with RCA>1) could suggest policy distortions or importance of other drivers of trade, e.g. economies of scale or economic geography.

24. Since the RCA index is a random variable a kernel density method estimation technique is used to estimate its density function. The method applied is called Epanechnikov kernel density estimation which is one the most efficient methods used to smoothen an actual empirical distribution of a variable (that can be represented by an histogram, for example). For details see description of the *kdensity* function in STATA Base Reference Manual, Stata Corporation.

25. This index is calculated according to the $BIL_{ij} = \frac{RCA-1}{RCA+1} \equiv \frac{X_{ij} * X_w - X_{wj} * X_i}{X_{ij} * X_w + X_{wj} * X_i}$ formula and is an approximation of the log transformation of the RCA index. Its values fall within [-1;+1] range key advantage is symmetry. A country is deemed to have a revealed comparative advantage in sector if the index takes a value above 0.

26. Coefficient of variation is defined as the standard deviation from the mean divided by the mean.

27. Some readers may wonder whether differences between China and the United States could be attributed to the general evolution of trade balances in these two countries but this is not the case since RCA are relative trade shares, i.e. they compare share of products in countries' exports with shares of products in world exports.

28. This is based on the t-statistics on coefficients of the simple OLS regressions, results available upon request.

29. A decile is any of the nine values that divide the sorted data into ten equal parts, so that each part represents 1/10 of the sample or population, here the RCA index.

30. Indeed, before the recent wave of globalisation occurred, in the late 1980s OECD countries accounted for approximately 70% of world trade.

31. For Germany and France, the lines are somewhat downward-sloping indicating that RCA distributions are shifting to the left.

32. Results are available upon request (tad.contact@oecd.org).

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Annex 3.A

Country trade shares and RCA indices

Changes in a country's overall trade shares are related to developments in individual product shares. Consider the identity (2) where a country's share in world trade is expressed as a weighted average of its shares in particular product markets, weights being shares of particular products in world trade (Equation 2). One implication of this is that only certain patterns of changes in product shares (X_{ij}/X_{wj}) would be associated with increases in country shares (X_i/X_w). Namely, product shares would need to increase on average, where average refers to an average weighted by product shares in world trade (X_{wj}/X_w). Whether this is the case would depend on many factors and in particular where any thus far unexploited comparative advantage may lie as well as on policy incentives and distortions across product space.

$$\frac{Xi}{X_W} = \sum_j \frac{X_{ij}}{X_{wj}} * \frac{X_{wj}}{X_w} \qquad (2)$$

$$1 = \sum_j RCA_{ij} * \frac{X_{wj}}{X_w} \qquad (3)$$

Another related implication of (2) is that there is not any illuminating relationship between changes in general competitiveness and RCA indices. Consider a situation of equal weights of products in world trade (X_{wj}/X_w=1 /j for all j). In such a case products for which X_{ij}/X_{wj} increased by more than average would display an increase in RCA but there would be other products with a positive change in X_{ij}/X_{wj}, i.e. products that are successful in their respective markets. When the weights are not equal we can observe that relatively larger changes in RCAs are possible for products that are not traded intensely in the world markets. Alternatively, a given percentage point increase in the world market for a particular product results, ceteris paribus, in a larger impact on our measure of revealed comparative advantage the less traded worldwide the given product is. However, a given proportional increase in the world market for a particular product results, ceteris paribus, in a larger impact on country's share in world trade the more traded the given product is.

A further insight into the nature of the relationship between country trade shares and RCA indices can be gained by dividing both sides of (2) by (X_i/X_w). The resulting expression (3) the tells us that for any country the weighted average of RCA indices equals one, weights being again shares of particular products in world trade. First, this indicates an increase in an RCA calculated for a particular product must be associated with a decrease of an RCA for at least one other product. This is an interesting property of the index as it entails the trade-off of expanding export specialisation in any particular area. Second, (3) holds for any increase or decrease in general competitiveness (X_i/X_w) which means that, in principle, any pattern of changes in RCA consistent with (3) could lead to an increase in (X_i/X_w).

Annex 3.B

Mobility indices

It is possible to reduce the information contained in transition matrices to single statistics that evaluate the degree of mobility and allow for cross-matrix comparison. Geweke *et al* (1986) propose the following two indices that have been later widely applied in the empirical analysis (Hinloopen and van Marrewijk, 2004; Redding, 2002; Proudman and Redding, 2000) and are employed in this chapter.

i. $M_1 = \dfrac{m - tr[p]}{m-1}$ (23)

where m is the number of columns/rows and tr(p) is the trace of the matrix. High M1 implies high mobility.

ii. $M_2 = \sum_k \pi_k \sum_l p_{kl} |k - l|$ (24)

M2 evaluates the information on the average number of class boundaries crossed by a product originally in state k weighted by the corresponding proportions π of the ergodic distribution:[a] high M2 implies high mobility.

a. The "ergodic distribution" can be interpreted as a limit to which a specialisation pattern would tend if the evolutions that characterized the period of analysis went on indefinitely.

Annex 3.C.

Figures and tables

Annex Table 3.C1. Broad sectoral classification based on HS chapter classification

Animal and animal products (01-05)
Vegetable products (06-15)
Foodstuffs (16-24)
Mineral products (25-27)
Chemicals and allied industries (28-38)
Plastics / rubbers (39-40)
Raw hides, skins, leather, and furs (41-43)
Wood and wood products (44-49)
Textiles (50-63)
Footwear / headgear (64-67)
Stone / glass (68-71)
Metals (72-83)
Machinery / electrical (84-85)
Transportation (86-89)
Miscellaneous (90-97)

Annex Table 3.C2. Balassa's index of specialisation by country and broad sector in 1993

Reporter	Animal & Animal Products (01-05)	Vegetable Products (06-15)	Foodstuffs (16-24)	Mineral Products (25-27)	Chemicals and Allied Industries (28-38)	Plastics / Rubbers (39-40)	Raw Hides, Skins, Leather, & Furs (41-43)	Wood & Wood Products (44-49)	Textiles (50-63)	Footwear / Headgear (64-67)	Stone / Glass (68-71)	Metals (72-83)	Machinery / Electrical (84-85)	Transportation (86-89)	Miscellaneous (90-97)
ARE	0.3	1.0	0.2	2.2	0.2	0.1	0.4	0.1	0.1	0.5	0.4	0.7	0.1	0.5	0.1
ARG	4.1	5.0	4.4	0.8	1.3	0.3	3.9	0.4	0.4	0.4	0.4	0.7	0.2	0.4	0.2
AUS	2.7	1.2	0.7	3.3	0.4	0.2	1.5	0.7	0.6	0.3	1.0	0.9	0.3	0.5	0.2
BRA	1.1	1.7	3.8	1.8	1.0	0.7	1.3	1.5	0.9	2.2	0.9	2.0	0.6	0.9	0.4
CAN	1.2	0.7	0.7	1.9	0.8	0.8	0.5	1.8	0.2	0.3	0.5	0.9	0.4	1.7	0.3
CHE	0.1	0.2	0.5	0.2	2.1	1.0	0.4	0.9	0.7	0.2	2.0	1.1	1.8	0.6	2.9
CHL	4.4	4.3	3.2	6.4	1.8	0.2	0.1	2.2	0.2	0.2	1.7	2.6	0.1	0.2	0.1
CHN	1.8	2.3	1.5	2.2	1.4	0.4	2.7	1.1	4.2	6.6	1.0	1.3	0.6	0.4	1.8
CZE	0.9	1.2	1.0	5.3	1.3	1.1	1.1	1.8	1.4	3.6	4.2	2.4	1.2	3.0	1.2
DEU	0.4	0.5	0.7	0.7	1.4	1.4	0.5	1.0	0.8	0.3	1.1	1.3	1.5	1.3	1.0
DNK	5.2	1.4	2.6	0.6	0.7	0.8	4.5	1.0	0.7	0.3	1.2	0.5	1.1	0.7	1.1
ESP	1.1	3.0	1.6	1.9	0.9	0.9	2.3	1.4	0.9	0.9	1.6	1.1	0.7	1.3	0.5
FIN	0.2	0.2	0.5	1.5	0.9	0.8	2.9	6.3	0.3	0.3	0.7	1.4	1.2	1.2	0.5
GBR	0.8	0.4	0.9	0.7	1.3	0.9	0.7	0.8	0.7	0.5	1.2	1.0	1.0	1.0	0.9
GRC	1.8	4.1	5.9	4.9	0.6	0.5	4.8	0.4	3.0	0.5	1.2	1.0	0.2	0.2	0.4
HKG	0.6	0.5	0.4	0.3	0.4	1.0	3.5	0.7	2.6	4.9	0.7	0.8	1.0	0.5	2.4
HUN	5.4	3.1	3.7	1.4	1.0	1.3	1.1	1.1	1.6	2.2	1.9	1.4	0.9	1.4	0.5
IDN	2.1	2.6	1.2	2.9	0.4	0.9	0.6	3.5	2.7	3.5	0.6	0.4	0.2	0.5	0.5
IND	2.8	5.2	2.7	4.0	1.1	0.5	8.9	0.2	4.3	1.6	1.5	1.4	0.2	0.7	0.3
IRL	3.0	0.5	1.5	0.6	1.7	0.6	0.7	0.4	0.6	0.3	1.0	0.5	0.6	0.1	0.7
ISL	55.6	6.7	6.5	10.7	0.0	0.1	3.9	0.1	0.7	0.0	0.3	1.7	0.3	0.7	0.2
JPN	0.1	0.1	0.1	0.3	0.8	0.8	0.2	0.2	0.4	0.1	0.8	1.0	1.6	1.5	1.3
MAR	11.0	6.6	5.0	19.9	3.9	0.1	1.9	1.9	3.1	1.4	0.6	0.4	0.2	0.2	0.3
MEX	0.4	1.7	0.6	0.8	0.9	0.7	0.5	0.6	0.7	0.7	0.8	0.8	1.1	0.8	0.8
MYS	0.6	1.8	0.8	0.5	0.2	1.6	0.1	1.8	0.7	0.5	0.6	0.7	0.9	0.4	0.6
NLD	2.3	2.3	2.5	1.1	1.4	1.5	0.6	0.9	0.5	0.3	0.7	0.8	0.7	0.6	0.7
NOR	6.0	0.2	0.5	2.6	0.4	0.2	0.6	1.0	0.2	0.1	0.4	1.0	0.3	1.0	0.3
NZL	16.7	2.2	1.2	0.5	1.0	0.3	7.0	2.8	0.8	0.3	0.2	0.7	0.3	0.2	0.2
PRT	0.8	0.6	1.1	3.3	0.5	0.5	1.0	5.6	3.7	4.5	1.8	0.6	0.6	0.4	0.5
SAU	0.1	0.2	0.1	1.2	0.9	0.2	0.2	0.1	0.0	0.0	0.1	0.1	0.0	0.0	0.0
SGP	0.5	1.0	0.5	0.5	0.7	0.7	0.2	0.4	0.6	0.2	0.4	0.5	1.1	0.7	0.7
SWE	0.2	0.2	0.3	0.9	0.7	1.1	0.4	3.3	0.2	0.3	0.6	1.6	1.2	1.2	0.7
THA	2.9	2.8	3.6	1.0	0.4	1.8	1.4	0.4	2.0	2.7	1.1	0.4	0.7	0.4	1.3
TUN	5.1	3.7	0.5	2.7	3.3	0.3	0.9	1.2	4.6	2.5	0.6	0.4	0.3	0.2	0.4
TUR	1.8	7.1	3.2	5.8	0.7	0.6	2.4	0.2	5.0	0.4	1.2	1.4	0.3	0.3	0.2
USA	0.8	1.0	0.8	0.9	1.2	1.0	0.7	1.1	0.4	0.2	0.8	0.7	1.0	1.2	1.1
WLD	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0
ZAF	0.6	0.8	0.9	6.4	1.5	0.2	1.5	1.3	0.4	0.1	1.6	2.3	0.2	0.5	0.1

Source: Data from UN ComTrade, authors' calculations.

Annex Table 3.C3. Balassa's index of specialisation by country and broad sector in 2000

Reporter	Animal & Animal Products (01-05)	Vegetable Products (06-15)	Foodstuffs (16-24)	Mineral Products (25-27)	Chemicals and Allied Industries (28-38)	Plasyics / Rubbers (39-40)	Raw Hides, Skins, Leather, & Furs (41-43)	Wood & Wood Products (44-49)	Textiles (50-63)	Footwear / Headgear (64-67)	Stone / Glass (68-71)	Metals (72-83)	Machinery / Electrical (84-85)	Transportation (86-89)	Miscellaneous (90-97)
ARG	3.6	5.0	4.6	1.3	1.6	0.6	2.5	0.5	0.3	0.1	0.3	0.6	0.2	0.6	0.2
AUS	3.9	1.8	0.9	3.9	0.6	0.2	1.4	0.7	0.8	0.3	0.9	0.8	0.3	0.4	0.4
AUT	0.5	0.4	0.9	0.9	0.5	1.1	0.7	2.1	0.9	0.9	1.8	2.3	1.6	2.0	0.9
BEL	1.0	1.2	1.6	1.4	1.7	1.8	0.4	0.9	1.3	0.7	1.6	1.2	0.7	0.8	0.5
BRA	1.4	1.8	3.5	2.1	1.1	0.8	1.5	1.5	0.6	1.7	1.3	1.5	0.5	1.1	0.4
CAN	1.1	0.8	0.9	1.5	0.6	0.9	0.4	2.0	0.2	0.2	0.6	0.8	0.5	1.8	0.5
CHE	0.1	0.1	0.6	0.3	2.3	1.0	0.3	1.1	0.6	0.1	3.0	1.3	2.1	0.6	3.4
CHL	4.8	4.2	3.2	6.7	2.1	0.2	0.1	2.1	0.2	0.1	0.4	2.1	0.1	0.3	0.1
CHN	1.3	1.5	1.4	1.7	1.4	0.6	2.5	1.0	3.5	6.5	1.2	1.6	1.0	0.9	2.3
CZE	0.5	0.7	0.8	3.2	0.8	1.6	0.6	2.1	1.4	2.5	3.8	2.0	1.6	2.2	1.2
DEU	0.5	0.6	0.8	0.7	1.3	1.5	0.4	1.2	0.6	0.3	1.1	1.3	1.6	1.4	1.0
DNK	5.5	1.6	2.3	0.7	0.7	0.7	4.5	0.9	0.8	0.5	0.9	0.7	1.4	0.8	1.1
EGY	0.5	4.6	1.8	9.4	1.4	0.8	0.4	0.2	5.0	0.3	5.0	1.1	0.1	0.0	0.2
ESP	1.7	2.8	1.9	2.2	1.0	1.1	1.8	1.6	1.1	1.1	1.4	1.1	0.9	1.6	0.6
EST	1.5	0.6	1.4	2.5	1.6	0.6	3.4	4.0	1.8	1.1	0.9	1.0	0.5	0.6	1.0
FIN	0.2	0.2	0.3	1.1	1.0	0.8	3.5	5.3	0.2	0.2	0.6	1.2	1.4	0.7	0.5
FRA	1.2	1.0	1.5	0.8	1.2	1.2	1.1	1.2	0.9	0.4	1.1	1.1	1.0	1.5	0.8
GBR	0.7	0.4	0.9	0.7	1.2	0.8	0.5	0.8	0.6	0.5	1.2	0.9	1.0	0.9	1.0
GRC	3.0	3.4	5.7	4.7	0.8	0.8	4.6	0.6	2.0	0.3	1.4	1.2	0.4	0.6	0.4
HKG	0.7	0.4	0.2	0.2	0.4	1.1	4.3	0.8	2.5	4.4	0.9	0.8	1.1	0.2	3.2
HUN	2.9	1.2	1.7	0.6	0.5	1.1	1.2	1.1	0.9	1.1	1.0	0.8	1.4	1.3	0.6
IDN	1.5	2.5	1.1	1.6	0.7	1.3	0.6	3.3	2.5	2.6	0.9	0.5	0.4	0.3	0.8
IND	2.3	6.0	0.9	4.0	1.7	0.7	7.1	0.2	5.5	2.5	2.3	1.3	0.4	0.8	0.3
IRL	1.5	0.3	1.1	0.2	2.1	0.4	0.4	0.2	0.2	0.1	0.4	0.2	0.5	0.1	0.6
ISL	54.6	7.2	8.1	16.4	0.3	0.2	4.3	0.1	0.7	0.1	0.2	1.0	0.7	1.7	0.3
ISR	0.2	1.4	0.7	0.5	2.7	1.0	0.2	0.3	0.7	0.1	1.4	0.6	0.7	0.5	0.8
ITA	0.5	0.9	1.5	0.7	0.7	1.3	2.6	0.9	1.9	2.7	2.0	1.3	1.8	1.3	1.2
JPN	0.1	0.1	0.1	0.3	1.0	0.9	0.1	0.2	0.4	0.1	0.9	1.0	1.5	1.4	1.4
KAZ	0.2	0.7	0.2	3.6	1.7	0.0	0.8	0.1	0.1	0.0	0.8	3.3	0.1	0.2	0.1
KOR	0.7	0.3	0.3	0.3	0.7	1.2	1.2	0.4	1.6	1.1	0.5	1.0	0.9	1.1	0.6
LUX	0.6	0.8	1.6	1.7	0.3	2.9	0.1	1.5	0.8	0.1	2.0	5.4	0.8	0.4	0.3
MAR	13.2	5.2	4.1	8.2	3.3	0.1	2.1	1.4	3.4	2.4	0.6	0.4	0.2	0.0	0.3
MEX	0.3	1.1	0.6	0.5	0.5	0.7	0.6	0.4	0.9	0.5	0.8	0.6	1.0	1.2	0.8
MYS	0.4	1.2	0.5	0.5	0.4	1.4	0.1	1.1	0.5	0.3	0.6	0.5	0.8	0.2	0.8
NGA	0.0	0.5	0.0	1.7	0.0	0.0	0.1	0.0	0.1	0.1	0.3	0.0	0.0	0.2	0.0
NLD	2.2	2.4	2.2	1.2	1.4	1.2	0.5	0.9	0.5	0.4	0.5	0.8	0.7	0.7	0.9
NOR	5.9	0.2	0.3	2.3	0.4	0.2	0.4	0.8	0.1	0.0	0.2	0.7	0.3	0.6	0.3
NZL	21.9	3.1	2.3	1.6	1.1	0.4	7.3	3.1	0.9	0.3	0.2	0.7	0.5	0.5	0.2
POL	1.3	1.7	1.8	2.3	1.1	1.3	1.6	2.5	1.3	1.4	2.0	1.8	0.9	2.1	0.9
PRT	1.1	0.7	1.2	1.7	0.5	0.8	0.8	5.8	3.0	4.5	1.8	0.8	0.8	0.9	0.6
RUS	0.4	0.2	0.1	1.8	1.0	0.4	0.5	0.9	0.2	0.1	1.1	1.5	0.4	1.0	0.2
SAU	0.1	0.1	0.1	0.3	0.8	0.2	0.1	0.1	0.1	0.0	0.3	0.1	0.0	0.1	0.0
SGP	0.3	0.6	0.3	0.3	0.8	0.6	0.5	0.3	0.3	0.1	0.3	0.4	0.9	0.4	0.7
SVK	0.4	0.6	1.0	2.2	1.0	1.3	0.7	2.0	0.9	1.8	1.4	1.8	1.0	2.8	0.5
SVN	0.4	0.4	0.9	0.7	0.9	1.7	2.9	2.6	1.3	1.1	2.4	2.1	1.4	1.5	1.7
SWE	0.6	0.3	0.4	0.9	0.7	1.1	0.3	2.8	0.3	0.3	0.5	1.4	1.3	1.2	0.7
THA	2.0	2.4	3.6	1.1	0.4	2.4	1.0	0.7	1.5	1.5	1.3	0.6	0.7	0.5	0.9
TUN	2.3	3.0	0.9	2.6	3.9	0.4	2.2	0.9	5.2	3.9	0.4	0.4	0.4	0.2	0.6
TUR	0.3	4.7	3.5	5.2	1.0	0.8	2.0	0.3	6.0	0.5	1.8	1.4	0.5	0.8	0.3
TWN	1.1	0.2	0.2	0.2	0.5	1.4	0.6	0.4	1.8	1.8	0.4	1.7	1.3	1.6	1.4
UKR	0.8	2.2	1.4	4.6	1.7	0.5	0.9	1.0	0.7	0.9	0.9	6.2	0.6	1.4	0.1
USA	0.8	1.0	0.9	0.9	1.3	1.2	0.7	1.0	0.5	0.2	1.0	0.8	1.1	1.2	1.2
VEN	0.2	0.4	0.3	0.6	0.5	0.2	0.2	0.1	0.0	0.0	0.2	1.1	0.0	0.1	0.0
VNM	11.0	8.7	1.1	2.4	0.4	1.1	2.1	2.0	4.0	14.9	2.6	0.4	0.3	0.5	0.7
WLD	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0
ZAF	0.9	1.4	1.5	8.3	2.0	0.4	3.1	1.7	0.5	0.3	1.6	2.8	0.5	0.8	0.3

Source: Data from UN ComTrade, authors' calculations.

Annex Table 3.C4. Balassa's index of specialisation by country and broad sector in 2007

Reporter	Animal & Animal Products (01-05)	Vegetable Products (06-15)	Foodstuffs (16-24)	Mineral Products (25-27)	Chemicals and Allied Industries (28-38)	Plasyics / Rubbers (39-40)	Raw Hides, Skins, Leather, & Furs (41-43)	Wood & Wood Products (44-49)	Textiles (50-63)	Footwear / Headgear (64-67)	Stone / Glass (68-71)	Metals (72-83)	Machinery / Electrical (84-85)	Transportation (86-89)	Miscellaneous (90-97)
ARE	0.2	0.5	0.3	0.9	0.1	0.2	0.6	0.2	0.5	0.3	1.1	0.6	0.2	0.3	0.4
ARG	3.4	4.9	4.3	2.0	1.3	0.6	1.7	0.6	0.4	0.1	0.3	0.5	0.2	0.5	0.1
AUS	3.8	1.1	0.7	4.4	0.6	0.2	2.6	0.8	0.6	0.1	0.8	0.8	0.3	0.4	0.4
AUT	0.5	0.5	1.0	0.9	0.5	1.2	0.5	2.1	0.7	0.7	1.8	1.8	1.7	1.9	1.1
BEL	0.9	1.1	1.3	1.4	1.9	1.7	0.4	1.0	1.0	0.8	1.3	1.1	0.6	0.7	0.6
BRA	2.9	1.6	3.4	1.6	0.8	0.7	1.8	1.2	0.6	1.1	1.0	1.0	0.5	1.2	0.3
CAN	1.3	1.2	0.8	1.5	0.7	0.8	0.6	1.8	0.2	0.2	0.5	0.8	0.6	1.3	0.5
CHE	0.1	0.2	0.6	0.2	2.1	0.8	0.4	0.7	0.4	0.2	2.2	1.0	2.0	0.6	4.0
CHL	3.4	2.4	1.7	3.5	1.3	0.2	0.1	1.4	0.1	0.1	0.3	1.5	0.0	0.1	0.0
CHN	0.5	0.7	0.8	0.7	1.1	0.6	1.9	0.8	2.9	4.3	1.2	1.5	1.2	0.8	1.7
CZE	0.5	0.5	0.6	1.5	0.5	1.3	0.4	2.0	0.9	0.8	2.2	1.5	1.6	1.7	1.0
DEU	0.5	0.5	0.8	0.6	1.1	1.4	0.4	1.2	0.6	0.4	1.1	1.2	1.5	1.4	1.0
DNK	4.8	1.7	2.0	1.1	0.9	0.8	3.7	0.9	0.8	0.6	1.3	0.8	1.4	0.8	1.1
EGY	0.3	3.6	1.6	7.0	0.5	0.5	0.3	0.3	1.1	0.0	0.9	0.9	0.0	0.0	0.2
ESP	2.1	2.9	1.8	1.7	1.1	1.2	1.7	1.8	1.1	1.0	1.3	1.1	0.9	1.6	0.6
EST	1.2	0.7	1.5	2.7	0.7	0.7	2.3	5.9	0.9	0.7	1.1	1.0	0.7	1.2	1.4
FIN	0.3	0.3	0.3	1.1	1.2	0.8	2.2	4.9	0.2	0.2	0.8	1.4	1.5	1.3	0.5
FRA	1.2	1.1	1.5	0.8	1.1	1.3	1.3	1.2	0.8	0.6	1.0	1.0	1.0	1.5	1.1
GBR	0.9	0.4	0.9	0.7	1.2	1.0	0.6	0.9	0.6	0.5	1.2	1.0	0.9	0.8	1.2
GRC	4.1	2.8	5.3	4.7	0.7	1.2	5.8	0.7	1.7	0.5	1.0	1.8	0.5	0.4	0.5
HKG	0.6	0.2	0.1	0.1	0.3	0.9	4.7	0.6	2.2	2.7	1.1	0.6	1.2	0.1	2.8
HUN	1.5	0.8	1.2	0.4	0.5	1.1	0.5	1.0	0.4	0.5	0.9	0.7	1.3	1.1	0.6
IDN	1.9	3.7	1.4	2.3	0.7	1.7	0.5	2.8	2.4	3.9	0.8	0.8	0.6	0.5	1.8
IND	1.7	3.7	1.4	4.3	1.6	0.7	3.4	0.3	3.5	1.8	2.0	1.6	0.4	0.7	0.5
IRL	1.6	0.3	1.5	0.3	2.5	0.3	0.5	0.3	0.1	0.1	0.3	0.3	0.4	0.2	0.7
ISL	36.2	4.0	2.5	3.8	0.2	0.2	1.4	0.1	0.3	0.0	1.1	0.8	0.6	3.2	0.3
ISR	0.2	1.4	0.5	0.4	2.0	0.9	0.0	0.3	0.4	0.2	1.9	0.7	0.6	0.5	0.9
ITA	0.5	0.9	1.5	0.6	0.7	1.3	3.1	1.0	1.9	2.3	1.5	1.4	2.0	1.3	1.2
JPN	0.3	0.1	0.1	0.4	1.1	1.1	0.1	0.3	0.4	0.1	1.2	1.0	1.6	1.4	1.3
KAZ	0.2	0.4	0.2	3.5	0.9	0.0	0.5	0.0	0.1	0.0	0.3	1.4	0.0	0.1	0.0
KOR	0.4	0.1	0.2	0.3	0.8	1.3	0.4	0.2	0.9	0.5	0.4	1.0	0.9	1.2	0.6
LUX	0.7	0.5	1.6	1.3	0.4	2.3	0.1	1.8	0.8	0.1	1.7	4.3	1.0	1.0	0.3
MAR	10.4	5.7	3.9	14.4	2.9	0.2	1.6	0.9	3.5	3.1	0.6	0.7	0.5	0.2	0.3
MEX	0.4	1.2	0.6	0.5	0.6	0.7	0.5	0.4	0.4	0.3	0.7	0.7	0.9	1.3	1.0
MYS	0.6	1.4	0.7	0.6	0.6	1.8	0.1	1.1	0.4	0.3	0.8	1.1	1.3	0.3	1.6
NLD	1.9	2.2	1.9	0.9	1.5	1.1	0.4	0.8	0.5	0.4	0.4	0.7	0.8	0.8	0.7
NOR	6.1	0.2	0.2	2.2	0.4	0.1	0.3	0.6	0.1	0.1	0.2	0.5	0.3	0.4	0.5
NZL	25.0	2.4	2.5	0.6	0.9	0.3	5.3	2.8	0.9	0.4	0.2	0.5	0.6	0.8	0.5
POL	1.6	1.1	1.6	0.9	0.7	1.5	0.8	2.0	0.7	0.7	1.5	1.3	1.1	1.8	0.8
PRT	1.7	0.8	1.5	1.7	0.5	1.2	1.0	6.3	2.2	4.7	2.0	1.0	0.8	1.1	0.6
RUS	0.2	0.2	0.3	1.3	0.6	0.4	0.1	0.9	0.1	0.0	0.5	0.9	0.2	0.4	0.1
SAU	0.2	0.1	0.2	0.8	0.6	0.3	0.2	0.2	0.1	0.0	0.2	0.1	0.0	0.3	0.0
SGP	0.3	0.3	0.3	0.4	1.0	0.6	0.4	0.2	0.2	0.1	0.3	0.5	1.0	0.5	0.9
SVK	0.6	0.5	0.8	1.4	0.4	1.0	0.6	1.3	0.6	1.4	1.1	1.3	1.0	2.2	0.7
SVN	0.4	0.4	0.5	0.7	0.8	1.5	1.6	1.6	0.9	0.6	1.3	2.0	1.5	1.7	1.1
SWE	1.4	0.3	0.5	0.7	0.6	1.1	0.3	3.1	0.3	0.4	0.5	1.4	1.4	1.2	0.8
THA	1.3	1.9	3.4	0.9	0.5	2.8	0.4	0.9	1.4	0.8	1.6	0.7	0.9	1.0	1.0
TUN	10.4	3.8	0.6	2.4	2.8	0.5	1.7	0.9	4.3	5.2	0.6	0.7	0.5	0.5	0.9
TUR	0.4	2.8	2.0	3.1	0.4	1.1	1.4	0.5	4.2	0.5	1.5	1.3	0.7	1.1	0.4
UKR	0.5	2.0	2.1	4.8	1.2	0.5	0.9	1.5	0.4	0.5	0.8	3.2	0.6	5.9	0.2
USA	0.8	1.3	0.8	0.9	1.5	1.2	0.7	1.1	0.4	0.2	1.2	0.8	1.0	1.5	1.4
VNM	4.5	5.3	1.3	1.3	0.2	1.3	2.2	1.4	3.3	8.1	1.2	0.5	0.4	0.5	1.1
WLD	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0
ZAF	0.9	1.1	1.0	8.5	1.6	0.4	1.9	1.3	0.4	0.4	3.9	2.0	0.6	0.6	0.3

Source: Data from UN ComTrade, authors' calculations.

Annex Table 3.C5. Change in the value of RCA, 1993-2007

Reporter	Animal & Animal Products (01-05)	Vegetable Products (06-15)	Foodstuffs (16-24)	Mineral Products (25-27)	Chemicals and Allied Industries (28-38)	Plastics / Rubbers (39-40)	Raw Hides, Skins, Leather, & Furs (41-43)	Wood & Wood Products (44-49)	Textiles (50-63)	Footwear / Headgear (64-67)	Stone / Glass (68-71)	Metals (72-83)	Machinery / Electrical (84-85)	Transportation (86-89)	Miscellaneous (90-97)
ARG				1.2											
AUS											-0.2				
AUT	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
BEL	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
BRA					-0.2									0.3	
CAN		0.5													
CHE						-0.2						-0.1			
CHL											-1.4				
CHN	-1.2	-1.6	-0.7	-1.5				-0.3					0.6		
CZE		-0.7			-0.8		-0.7		-0.5	-2.8					-0.2
DEU								0.2							
DNK				0.4											
EGY	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
ESP					0.2	0.3			0.2	0.1					
EST	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
FIN					0.2										
FRA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
GBR												0.0		-0.2	0.3
GRC						0.6						0.8			
HKG						-0.2					0.4		0.3		
HUN		-2.4		-1.0	-0.6		-0.5		-1.2	-1.7	-1.0	-0.7	0.5		
IDN						0.7									1.3
IND															
IRL															
ISL											0.8	-0.9		2.5	
ISR	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
ITA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
JPN					0.3	0.3					0.4				
KAZ	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
KOR	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
LUX	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
MAR								-1.0							
MEX													-0.2	0.5	
MYS												0.4	0.4		1.1
NLD				-0.2											
NOR								-0.4				-0.5			
NZL															
POL	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
PRT	0.9					0.8	-0.1							0.6	
RUS	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
SAU				-0.5											
SGP		-0.7			0.3								-0.1		
SVK	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
SVN	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
SWE	1.2														
THA							-1.0			-1.9					
TUN							0.8	-0.3							
TUR	-1.4					0.5								0.8	
UKR	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
USA		0.3									0.3				
VNM	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
ZAF		0.4	0.1												

Changes in values are only reported for cases where there has been a switch from RCA<1 to RCA>1 or from RCA>1 to RCA<1; NA indicates lack of data for this country for the initial year.

Source: Data from UN ComTrade, authors' calculations.

Annex Table 3.C6. Change in the RCA status, 2000-2007

Reporter	Animal & Animal Products (01-05)	Vegetable Products (06-15)	Foodstuffs (16-24)	Mineral Products (25-27)	Chemicals and Allied Industries (28-38)	Plastics / Rubbers (39-40)	Raw Hides, Skins, Leather, & Furs (41-43)	Wood & Wood Products (44-49)	Textiles (50-63)	Footwear / Headgear (64-67)	Stone / Glass (68-71)	Metals (72-83)	Machinery / Electrical (84-85)	Transportation (86-89)	Miscellaneous (90-97)
ARG															
AUS															
AUT															0.2
BEL	-0.2								-0.3						
BRA					-0.3						-0.3				
CAN		0.4													
CHE								-0.3				-0.3			
CHL															
CHN	-0.8	-0.8	-0.5	-1.0									0.2		
CZE									-0.5	-1.7					-0.3
DEU															
DNK				0.3							0.4				
EGY					-1.0						-4.0	-0.2			
ESP															
EST					-0.9				-0.9	-0.4	0.2			0.6	
FIN					0.2									0.7	
FRA													0.0		0.3
GBR												0.1			0.2
GRC						0.3									
HKG						-0.2					0.2				
HUN		-0.4					-0.6			-0.7	-0.1				
IDN															1.0
IND			0.5												
IRL															
ISL											0.9				
ISR															
ITA															
JPN					0.1	0.2					0.2	0.1			
KAZ					-0.8										
KOR							-0.8		-0.7	-0.5					
LUX													0.2		
MAR								-0.6							
MEX															
MYS												0.6	0.4		0.8
NLD				-0.3											
NOR															
NZL				-1.0	-0.3										
POL				-1.3	-0.4		-0.8		-0.6	-0.7			0.1		
PRT						0.5								0.2	
RUS											-0.5	-0.6			
SAU															
SGP					0.3										
SVK			-0.2										0.1		
SVN									-0.4	-0.5					
SWE	0.8														
THA				-0.3			-0.6			-0.7					0.1
TUN															
TUR					-0.6	0.3								0.4	
UKR															
USA		0.3													
VNM															0.3
ZAF															

Changes in values are only reported for cases where there has been a switch from RCA<1 to RCA>1 or from RCA>1 to RCA<1; NA indicates lack of data for this country for the initial year.

Source: Data from UN ComTrade, authors' calculations.

Chapter 4

Changing patterns of trade in processed agricultural products

by
Peter S. Liapis[1]

This chapter is split into two parts. The first part focuses on monitoring recent trends in the trade of processed agricultural products and examines the leading exporting and importing countries of processed products. The second part examines which countries have a comparative advantage in exporting processed products and how these may have changed over time. Utilising information on comparative advantage and the methodology from Hausmann, Hwang and Rodrik (2007), the study assesses whether a country's export basket matters in generating growth.

Until the recent financial crisis and the subsequent collapse in world merchandise trade, trade in agricultural products increased smartly, driven by increasing incomes, enlarged population, lower transport costs, and greater market access as the implementation of the Uruguay Round Agreement on Agriculture (URAA) opened markets. Between 1995 and 2008, agricultural exports more than doubled from USD 464 billion to somewhat more than USD 1 trillion. A key driver is the trade expansion of higher valued processed products. International trade in agricultural products and food is increasingly shifting towards high-value products. Exports of processed agricultural products during the 1995 to 2008 period grew from USD 212 billion in 1995 to USD 492 billion in 2008. Processed products account for almost one-half of the value of international agricultural exports, even with the higher primary commodity prices that manifested in 2007-08. A country's ability to perform successfully as a participant in agricultural and food trade may depend more and more on the way it integrates into the processed product sectors. Furthermore, increasing exports of processed products has the potential to expand employment and income opportunities beyond the farm gate.

Firms that are engaged in exporting tend to be larger, more productive and more efficient than firms in the same industry that do not export. Exports can grow as firms export more and/or at higher prices for the products they've been producing to their existing partners (the intensive margin). Exports can also grow through market development as firms export their existing products to new partners or through innovation, developing new products and exporting them either to existing partners or to new markets (the extensive margin). At the intensive margin, higher volumes can be a reflection of higher prices evidencing higher quality, and/or by higher quantities. Increasing exports through higher volumes, at the intensive margin, can be a reflection of a country's comparative advantage and firms in those industries are exploiting economies of scale and are becoming more efficient. A potential downside is that relying on a fixed set of goods may lead to declining export prices from the expanded supply along with increased volatility from exogenous shocks. In this light, a diversified export basket is presumed to minimize the variability of export earnings while reducing the potential for declining terms of trade. Diversification, creating new or higher quality products and developing new trading partners, can spur productivity and economic growth. But, there is information and other learning costs to exporting as firms have to understand the various destination markets, tailor their products to satisfy local norms, ship over greater distances, and overcome custom and other administrative costs. The benefits of growing exports either through specialisation (intensive margin) or diversification (extensive margin) are increased profitability for the firms and higher employment and other social benefits for the home country. For the importing countries, lower prices, additional availability and variety of goods increase consumer welfare.

The various paths of export growth have only recently received attention in the literature. In examining export patterns it is not only useful to identify the countries that have comparative advantage in producing and exporting processed products, but also to account whether export growth has occurred in those industries exhibiting a comparative advantage.

It is not necessarily the case that the various paths are mutually exclusive. Literature suggests that diversification has an inverted U-shaped relationship with income. Diversification increases with income until income reaches a level comparable to the low-end of high income countries, after which diversification declines (Cadot *et al.*, 2008). There is probably an optimum mix of specialisation and diversification for any country at any point in time. This is beyond the scope of this chapter. This chapter sheds light on how diversified (across the product and partner space) a country's export basket is, which countries have comparative advantage, and examines the correlation between them.

This chapter is divided into two parts. The first part focuses on monitoring recent trends in the trade of processed agricultural products and examines the leading exporting and importing countries of processed products. The second part examines which countries have a comparative advantage in exporting processed products and how these may have changed over time. Utilising information on comparative advantage and the methodology from Hausmann, Hwang and Rodrik (2007), the study assesses whether a country's export basket matters in generating growth.

What agricultural products are considered processed?

Agricultural commodities consist of many different products, from very basic commodities requiring little if any modification for their consumption to highly complex and processed products. This distinction implies that agricultural products can be separated into those products that are closely dependant on climatic conditions for their production from those that are less dependent on climate and more on labour, capital and innovation to transform raw agricultural products into processed (food beverages and tobacco) products that are closer to the consumer's kitchen table. Agricultural products therefore are often classified into raw and processed products. A country's overall competitiveness and ability to export different types of raw agricultural products depends upon its innate natural resources, as well as on land, labour, capital and climatic conditions.

Products with a relatively high dependence on land availability and climatic conditions have been referred to by Regmi *et al* (2005) as land-based agricultural products. Other agricultural products (with a higher degree of processing) termed "foot-loose" on the other hand can be produced almost anywhere with imported raw products, technological knowhow and competitive labour and capital. For this chapter, agricultural trade has been segregated into four broad sub-sectors following Regmi *et al* (2005). These categories are two land-based sectors; (1) bulk commodities such as wheat or coffee, (2) horticultural commodities such as bananas, tomatoes, or cut flowers, and two foot-loose sectors; (3) semi-processed commodities such as wheat gluten, oilseed cake or vegetable oils, and (4) processed products, i.e. goods that require extensive transformation and are much closer to the consumers kitchen table, such as chocolates, beverages, and fresh or chilled meats.[2] The focus of this chapter is on processed products as defined in Regmi *et al*.[3]

Data

Trade data for this chapter are from *Centre d'Études Prospectives et d'Informations Internationales* (CEPII). The International Trade Database at the Product Level (BACI) starts with the UNCOMTRADE data and then treats the data to reconcile the declarations of exporters and importers. It thus expands the country coverage reported in the original COMTRADE data, converts the data into common quantity units and calculates unit values from that data while providing a more complete picture of international trade (see Gaulier and Zignago, 2009 for details).

An alternative source is the untreated data form UNCOMTRADE. Since the BACI data are more complete and consistent than the raw untreated COMTRADE data, they are used for this analysis. Unfortunately, the BACI data at the time of this writing stop in

2007. In order to get a better sense of the relative importance of processed products in agricultural trade, the more recent data that captures the relatively high commodity prices of 2008 from UNCOMTRADE are also used. Trade data in both sources include trade among EU members.

Data on income, agricultural value added, labour force, and other country level data are from the World Bank's World Development Indicators. Data on country groupings based on income is from the World Bank's list of economies (July, 2009). The Corruption Perception Index from Transparency International is used to measure corruption. The corruption perception index measures the perceived level of public sector corruption. It is a "survey of surveys" based on 13 different expert and business surveys focusing on corruption in the public sector. The index ranges from 10 representing least corrupt governments to 0 the most corrupt. Data on trade facilitation indicators (number of documents to export, time needed to export and transaction costs to export a standard 20-foot container) are from the World Bank's Trading Across Borders database.[4] The measures provide international comparisons of direct and indirect border-related costs that exporters typically face[5]. Unfortunately, these measures are not specific to trading agricultural products rather they represent averages for all merchandise trade. They may therefore, not be representative of the documents, time or cost to export processed products many of which may require additional documentation for food safety reason and also require refrigerated storage and transport or other special handling. Readers should bear this in mind in interpreting results presented below.

Trends in trade and production

Trends in agricultural trade

Agricultural exports more than doubled between 1995 and 2008, increasing from more than USD 464 billion to more than USD 1 trillion (Figure 4.1) a growth rate of 5.8% per year.[6] At the same time, total merchandise trade expanded even faster, growing from a little more than USD 5 trillion to more than USD 13.7 trillion (Figure 4.1), an annual growth rate of 8.2%. Consequently, agricultural share of total trade mostly declined over the period from around 9% to around 7% of total trade (Figure 4.2).

Figure 4.1. Agricultural and total merchandise trade

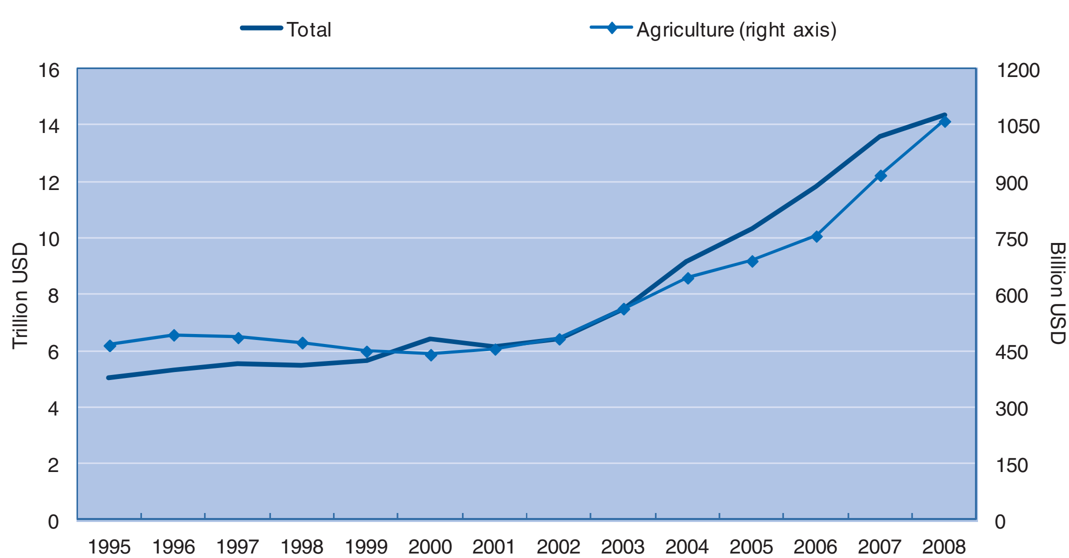
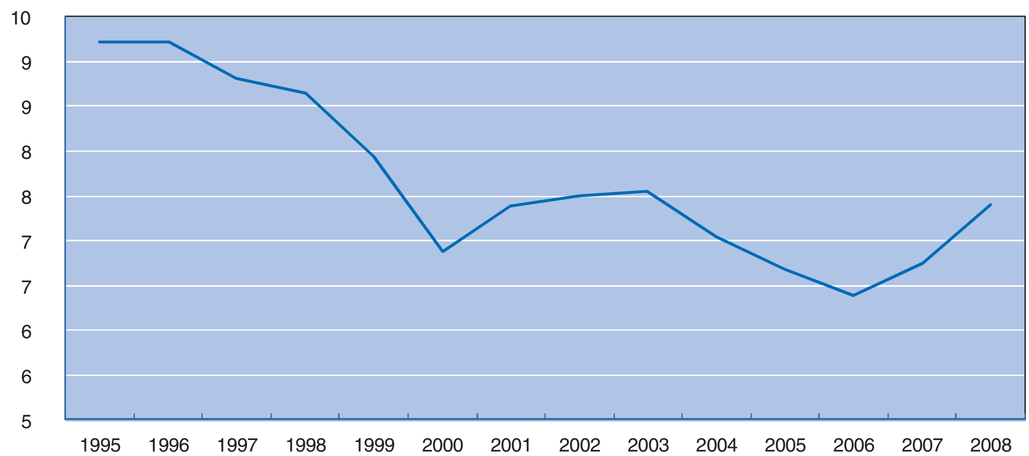


Figure 4.2. Share of agricultural trade in total merchandise trade

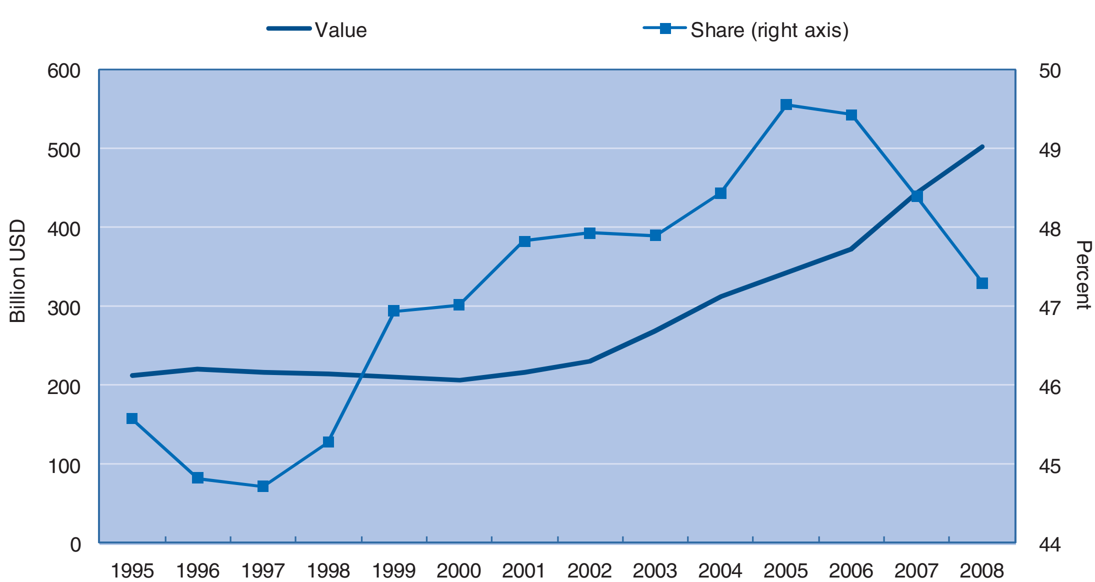
Percentages



Trends in trade of processed agricultural products

Trade in processed agricultural products also more than doubled from 1995 to 2008 going from more than USD 211 billion to almost USD half a trillion. Trade in these products grew at a faster rate than overall agricultural goods, showing an annual growth rate of 6.5% (Figure 4.3). Hence, their share of total agricultural trade increased from a little more than 45% in 1995 to 48% in 2008 (Figure 4.3). Note the rapid rise in the trade of these products starting in 2000 and the increase share of total agricultural trade which seems to have been halted in 2007-08, the time that coincides with the relatively high commodity prices mostly for products that are not processed.

Figure 4.3. Trade in processed agricultural products and their share of total agricultural trade

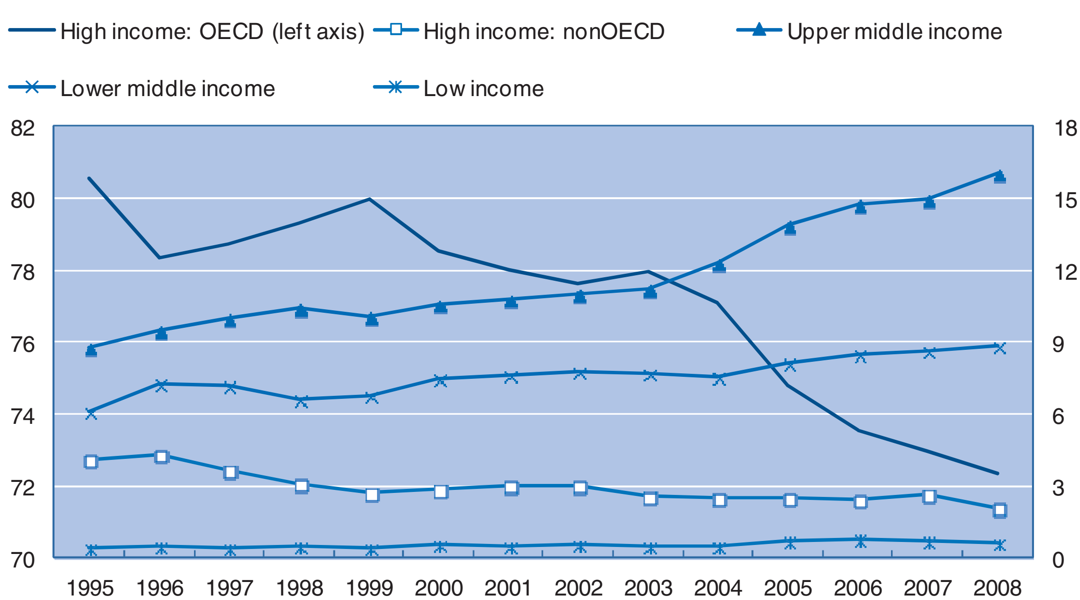


What types of countries are mostly engaged in exporting processed products? The World Bank classifies countries into several income categories based on their per capita income. The categories used in this report are as of July 2009. The classification is: 1) high income OECD countries[7] (26); 2) high income non-OECD countries (39); 3) upper middle income countries (42); 4) lower middle income countries (54); and 5) low income countries (49). The actual numbers used in this report varies by year based on data availability.

It seems that lower income countries, especially upper middle income countries have become much more competitive in these products as their exports grew at an average annual rate of almost 11%. Exports of processed products from low income countries, even though starting from a much smaller base, also expanded substantially over this time period suggesting that they too have become more competitive. As illustrated in Figure 4.4, lower income countries have increased their market share considerably over this time period at the expense of high income countries. Upper middle income countries have been especially successful almost doubling their market share to 16% of the total, while high income OECD countries lost about 8 percentage points over this time period, albeit still exporting about 73% of the total. While for low income countries, it is evident from Figure 4.4 that despite the impressive growth rate, the absolute value of their exports of processed products hardly registers at the world level.

Figure 4.4. Share of processed products exported by income classification

Percentages



Comparing exports of processed products from the five enhanced engagement countries (EE) (Brazil, China, India, Indonesia and South Africa) to the OECD countries (not just those with high incomes) presents a similar picture as above. Exports of processed products from the OECD countries are significantly larger by an order of magnitude (Table 4.1). In 2008, the OECD countries exported some eight times more processed products than the EE countries, but exports of processed products are growing much faster in the EE countries ranging from Brazil's almost 12.6% per year (double the growth rate for the OECD members) to South Africa's 6.1% rate. Hence, while at the beginning of the period EE countries supplied about 6% of processed products exports, in the latest three years, they supplied 9% of total processed products. The four countries that become OECD members in 2010 (Chile, Estonia, Israel and Slovenia) and Russia (an OECD accession country), as a group are relatively small agricultural exporters supplying about 2% of total processed products to world markets during 2006-08.

Table 4.1. Exports of processed products for OECD and Enhanced Engagement countries

Million USD

	OECD	Brazil	China	India	Indonesia	South Africa
1995	175 006	4 475	5 834	643	517	1130.39
1996	178 058	4 951	5 976	943	577	1220.50
1997	176 713	4 981	5 482	974	675	1185.91
1998	175 566	5 577	5 316	738	643	1171.01
1999	174 015	5 284	5 371	800	802	1172.43
2000	168 267	5 036	5 911	1 041	834	1285.00
2001	176 211	6 042	6 325	1 130	888	1362.99
2002	186 019	6 664	6 705	1 206	899	1551.55
2003	218 455	7 703	7 467	1 330	971	1860.67
2004	251 000	10 385	8 672	1 411	1 133	1932.46
2005	269 181	13 224	10 060	1 792	1 261	1985.08
2006	291 280	15 784	11 881	2 726	1 364	2048.77
2007	343 746	18 605	14 023	3 181	1 604	2354.60
2008	387 420	23 449	14 948	3 669	2 289	2098.10
Least squares growth rate						
	6.09	12.59	7.95	12.11	9.63	6.07

OECD: 30 Members in 2008.

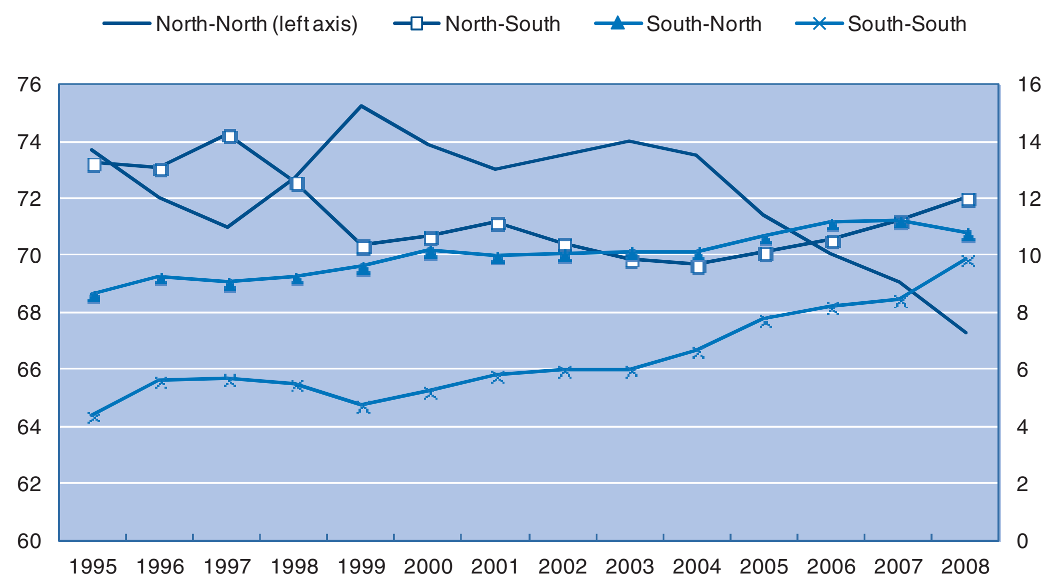
Direction of trade in processed products

Using the World Bank's income classification, trade flow are classified as North-North trade (NN) when both the exporting and importing countries have high income; North-South trade (NS) when the exporting country has high income while the importing country does not; it is classified as South-North (SN) when the exporting country is middle or low income while the importing country is high income, and lastly, when both partners are not high income their trade is classified as South-South (SS).

Data indicate that globalisation and the linking of countries through trade are well entrenched as each trade flow at least doubled during the time period while SS trade almost quintupled. Trade among rich countries grew at an average rate of 6.1% while trade among lower income countries grew at 11.6% annual rate. It is still the case, however, that trade in processed products is mostly among rich countries. In 2008, NN trade was almost double the combined trade of the other flows suggesting perhaps that income is not only an important demand factor for these products but also an indicator of supply availability. Interestingly, exports from the south to the north (SN) have caught up with trade from the north to the south (NS) as SN trade is growing at a much faster rate. Even though SS trade is growing very fast, to keep it in perspective, if NN trade remains constant at its 2008 level while SS trade continues at its current growth rate, it will take more than 18 years for SS trade to catch-up to current NN trade. Nonetheless, SS trade is growing representing a larger share of world trade in these goods while NN trade is becoming relatively less important. The data also seems to indicate that SS trade is replacing some NS trade as the share of exports from the north to the south has declined somewhat[8] (Figure 4.5).

Figure 4.5. Directional share of trade in processed products

Percentages



Major exporting countries

Moving away from broad aggregates and looking at individual countries, which ones are exporting the most and how has this changed over the time period? In order to reduce the particularities of any one year, average exports for the three year period 1995 to 1997 and 2006 to 2008 are used. During the first period, The 15 EU members as a group on average exported almost USD 126 billion (58% of total) with France the largest individual exporter with almost USD 25 billion (11% of the total). The United States with average exports of more than USD 22 billion (10%) was second with the Netherlands close behind while eight of the top nine exporting countries are members of the European Union (Table 4.2). Overall, the countries listed in Table 4.2 accounted for almost 83% of world's exports of processed products, with the OECD countries contributing three-quarters of the total. The two EE countries, China and Brazil, on average exported about 5% of world's total. It is apparent from the table that processed products exports are very concentrated with only a handful of countries exporting the vast majority of the goods.

A decade later the picture hardly changed. The now enlarged European Union[9] as a block still exports more than half of all processed products traded in the world. Although the rankings changed somewhat, exports of processed products remain highly concentrated. The European Union plus the other countries listed in the table export some 81% of world's total (slightly lower level of concentration as in the previous period) leaving very little for the other 200 some countries. OECD countries also continue to dominate trade in these products as the OECD countries listed in the table export some 70% of the world's total. Furthermore, only two non-OECD Member countries remain among the leading exporters as Poland and Austria replaced Argentina and Thailand on the list of top exporters. However, the two EE countries increased their competitiveness in these products as their market share expanded somewhat over the time period.

Table 4.2. Top exporters of processed agricultural products

	1995-97		2006-08		
	Value of exports Million USD	Share per cent		Value of exports Million USD	Share per cent
European Union[a]	125 709	58.07	European Union[a]	257 182	58.57
of which			*of which*		
France	*24 741*	*11.43*	*Germany*	*43 359*	*9.87*
Netherlands	*21 860*	*10.10*	*France*	*39 386*	*8.97*
Germany	*17 985*	*8.31*	*Netherlands*	*35 590*	*8.10*
United Kingdom	*13 432*	*6.20*	*Belgium/Luxemburg*	*22 476*	*5.12*
Belgium/Luxemburg	*11 239*	*5.19*	*Italy*	*21 310*	*4.85*
Italy	*9 706*	*4.48*	*United Kingdom*	*17 710*	*4.03*
Denmark	*7 809*	*3.61*	*Spain*	*14 568*	*3.32*
Ireland	*7 103*	*3.28*	*Denmark*	*12 032*	*2.74*
Spain	*5 407*	*2.50*	*Ireland*	*11 597*	*2.64*
United States	22 175	10.24	*Poland*	*9 889*	*2.25*
China	5 764	2.66	*Austria*	*7 873*	*1.79*
Australia	5 479	2.53	United States	31 563	*7.19*
Canada	5 094	2.35	Brazil	19 279	*4.39*
Brazil	4 802	2.22	China	13 617	*3.10*
New Zealand	4 777	2.21	Canada	12 315	*2.80*
Argentina	2 717	1.26	Australia	12 104	*2.76*
Thailand	2 657	1.23	New Zealand	11 185	*2.55*

a) Calculations for the European Union are based on15 members prior to 2004; 25 members 2004-06; 27 members as of 2007.

Major importing countries

Turning our attention to the other side of the ledger, which countries are large importers of processed products? Imports reported here are mirror statistics calculated from the export data discussed above. The advantage of this approach is that both exports and imports are valued on the same basis, that is, freight on board (fob) and thus excludes possible inconsistencies between import and export values. The disadvantage is that imports from some countries that do not appear as exporters are missing. This is not expected to be a major problem as most of the traders are included in the database, especially those accounting for the vast bulk of the trade.

Looking at a rather broad picture, not surprising given their ability to pay, high income countries import by far the majority of processed products. In the 2006-08 period, high income OECD countries imported on average almost USD 311 billion each of the three years (68% of the total). But, imports by middle and low income countries expanded significantly, more than doubling, and in the case of low income countries, tripling over the 13-year period (Table 4.3) possibly reflecting the high income growth of many of these countries especially in the latter part of the period.

Also not surprising, the top importers of processed products are dominated by high income and OECD countries, especially members of the European Union (Table 4.4). During 1995-97, only Russia and Brazil among the top importers is not a high income country and Brazil's imports during the second period are insufficient to maintain her among the leading importing countries. Interestingly, imports are less concentrated among the leaders relative to exports and the concentration ratio declined over time suggesting that other importing countries are becoming more engaged in trade. During 1995-97, the top importers shown in the table imported 77% of all processed products while by the 2006-08 period; their share had dropped to 73% (compared to a share of 81% for the top exporters). The relative worldwide prosperity and rising incomes over the last decade along with relatively more open markets, seems to have expanded import demand across a wide spectrum of countries.

Table 4.3. Average imports of processed products by income groups

Billion USD

	1995-97	2006-08
High income: OECD	150.763	310.909
High income: non-OECD	19.931	36.425
Upper middle income	24.854	59.484
Lower middle income	14.519	37.729
Low income	4.535	13.767

Among countries with observations in each year of the two periods (1995-97 and 2006-08), the fastest growing import markets for processed products are not high income countries, however. Two of the five fastest growing areas, Tokelau (average growth 29% a year) and French Southern and Antarctic Lands (average growth 28% a year), are small islands with small economies and populations. Their average imports during this period were USD 614 000 and USD 2.4 million respectively, thus the economic importance of such high growth rates should not be overestimated. Iraq (with an average import growth rate of 29% a year), Sudan (with an average growth rate of 21% a year) and Afghanistan (with an average growth rate of 19% a year) round out the top five fastest growing import markets. The appearance of these countries among the fastest growing markets is a surprise as two of them have been embroiled in war and all three have governance issues.

Among OECD countries, only six members exhibited double digit growth. Hungary with an average growth rate of 18% a year was the leader, followed by Slovakia and Poland with a growth rate of 15% a year, the Czech Republic with a growth rate of 14% a year, Mexico with a growth rate of 12% a year and Australia with 10% a year.

As a group, the five EE countries averaged USD 6.2 billion a year from 1995-97 and these jumped to more than USD 12 billion per year in 2006-08. On average, imports by each of the EE countries more than doubled over the time period (except in Brazil), perhaps reflecting the dynamic income growth by these countries over the time period. Brazil’s imports of processed products declined, exhibiting a negative growth rate of 4% a year perhaps because demand for these products is met through local production. Imports of processed products by the other EE countries grew between 8% a year (India) and 10% a year (South Africa). During 2006-08, China’s average imports of processed products were USD 5.3 billion a year while Indonesia averaged USD 2.6 billion a year. In contrast, although India’s imports of these products increased two and a half times, the level is fairly small, averaging USD 500 million a year.

Table 4.4. Top importing countries of processed products

	1995-97			2006-08	
Country/ region	Value of imports Million USD	Share per cent	Country/ region	Value of imports Million USD	Share per cent
European Union[a]	101 784	47.02	European Union[a]	229 678	48.85
of which			*of which*		
Germany	*22 635*	*10.46*	*Germany*	*36 592*	*7.78*
France	*15 264*	*7.05*	*United Kingdom*	*32 353*	*6.88*
United Kingdom	*14 808*	*6.84*	*France*	*26 261*	*5.59*
Italy	*11 027*	*5.09*	*Italy*	*20 796*	*4.42*
Netherlands	*10 123*	*4.68*	*Netherlands*	*19 838*	*4.22*
Belgium/Luxembourg	*9 138*	*4.22*	*Belgium/Luxemburg*	*15 989*	*3.40*
Spain	*5 205*	*2.40*	*Spain*	*13 292*	*2.83*
Greece	*2 678*	*1.24*	*Austria*	*5 902*	*1.26*
Japan	19 053	8.80	*Sweden*	*5 887*	*1.25*
United States	15 650	7.23	United States	41 433	8.81
Russia	9 615	4.44	Japan	23 189	*4.93*
Hong Kong, China	5 535	2.56	Russia	17 623	3.75
Canada	4 406	2.04	Canada	12 905	2.74
Singapore	2 862	1.32	Mexico	8 162	1.74
Korea	2 737	1.26	Hong Kong, China	6 688	1.42
Brazil	2 684	1.24	Switzerland	6 537	1.39
Switzerland	2 662	1.23	Korea	5 649	1.20

a) Calculations for the European Union are based on15 members prior to 2004; 25 members 2004-06; 27 members as of 2007.

Revealed comparative advantage and growth

The previous section described the evolution of the trade in processed products, which countries were the major exporters and importers and whether their share changed over time. Comparing market share over time is one indication of a country revealing an ability to "compete" or not by increasing or decreasing overall market share. But a country's market share is devoid of information of developments in other sectors of the economy. Several measures have been developed based on relatively easily available trade data as summary statistics encapsulating all the factors (market and non-market) leading to comparative advantage. In this section we use Balassa's revealed comparative advantage index, a popular index used to indicate products or sectors where a country has a comparative advantage.

The Balassa Index is the ratio of country's j share of exports in sector k relative to that country's exports in all sectors to the ratio of total world trade of sector k to the total world merchandise exports.[10]

$$RCA_{j,k} = (X_{j,k} / \sum_k X_{j,k}) / (\sum_j X_{j,k} / \sum_j \sum_k X_{j,k})$$

Where

$RCA_{j,k}$ = revealed comparative advantage for country j in sector k

$X_{j,k}$ = country j exports of sector k.

A value greater than 1 "reveals" that the country has a comparative advantage in that sector, values below 1 "reveal" that a country has a comparative disadvantage in that sector, while a value of 1 means that the country has neither advantage nor disadvantage. For this study, the sectors indexed by k are 1) all agriculture for an overview of the sector and 2) processed products subsector.

The Balassa Index was calculated for each year and for the EU members, their data exclude intra-EU trade. In most cases this does not make a difference. EU members that had (had not) comparative advantage when intra EU trade is included also had (had not) comparative advantage when only trade with third countries is considered.

Other than indicating whether or not a country has comparative advantage, it is not clear whether the absolute level of the calculated RCA has economic meaning. For example comparing the calculated value of the RCA between sectors in a country or between countries may be misleading as it's a ratio and small trade flows of products not widely traded can generate large outliers. Hence, for this exercise, the focus is on whether the calculated RCA for each country in each sectors is greater than or less than 1.

Based on this criterion, in 1997, of the 26 high income OECD countries, half had a comparative advantage in agriculture (Table 4.5a) while only five of the 31 (16%) high income non-OECD economies had an RCA index above 1. In contrast to the 134 emerging economies in the database in 1997, at least 70% of the countries in each income group had a comparative advantage in agriculture.

Looking specifically at processed products, a somewhat different picture emerges. There are more high income (OECD or not) countries with comparative advantage compared to overall agriculture while there are fewer emerging economies (Table 4.5b). The results suggest that a total of 16 high income OECD countries had comparative advantage in processed products. Belgium-Luxembourg, the Czech Republic, United Kingdom and Italy appear to have comparative advantage in processed products while Canada does not in contrast to their standing in all agricultural products. The European Union as a single trader, (i.e. by aggregating the individual EU members into a single block) appears to have a comparative advantage in processed products but not in agriculture. Among the low income countries, only seven appear to have comparative advantage in processed products (compared to 38 in agriculture). Among lower middle income countries, there are 17 fewer with comparative advantage in processed products while five fewer upper middle income countries have comparative advantage. Among upper middle income countries that appear to have comparative advantage are three OECD countries, Mexico, Poland and Turkey.

In 2007, among high income OECD countries, Belgium-Luxembourg joined the other 13 countries with a comparative advantage in agriculture (Table 4.6a). There were marginal changes to the composition of countries with revealed comparative advantage in agriculture in the other income groups as well. For example, among low income countries Gambia and Sierra Leone increased their comparative advantage to above 1 in 2007 while Chad's dropped to less than 1. Overall, the group of lower middle income countries had a net increase of five countries while there was a net gain of two among upper middle income countries with comparative advantage in agriculture.

Table 4.5a. Countries with comparative advantage in agriculture (1997)

		Agriculture		
High income: OECD	**High income: nonOECD**	**Upper middle income**	**Lower middle income**	**Low income**
Australia	Andorra	Argentina	Albania	Afghanistan
Canada	Barbados	Bulgaria	Armenia	Burundi
Denmark	Cyprus	Belize	Azerbaijan	Benin
Spain	Estonia	Brazil	Bosnia and Herzegovina	Burkina Faso
France	Trinidad and Tobago	Chile	Bolivia	Central African Republic
Greece		Costa Rica	Bhutan	Côte d'Ivoire
Hungary		Cuba	Cameroon	Comoros
Ireland		Dominica	Colombia	Eritrea
Iceland		Fiji	Djibouti	Ethiopia
Netherlands		Grenada	Dominican Republic	Ghana
New Zealand		Croatia	Ecuador	Guinea-Bissau
Portugal		Jamaica	Egypt, Arab Rep.	Haiti
United States		Kazakhstan	Georgia	Kenya
		St. Kitts and Nevis	Guatemala	Kyrgyz Republic
		Lebanon	Guyana	Lao PDR
		St. Lucia	Honduras	Madagascar
		Lithuania	Indonesia	Mali
		Mauritius	India	Myanmar
		Panama	Jordan	Mozambique
		Poland	Kiribati	Malawi
		Suriname	Sri Lanka	Niger
		Turkey	Morocco	Nepal
		Uruguay	Moldova	Pakistan
		St. Vincent and the Grenadines	Marshall Islands	Papua New Guinea
		South Africa	Macedonia, FYR	Rwanda
			Mongolia	Senegal
			Nicaragua	Solomon Islands
			Peru	Somalia
			Paraguay	São Tomé and Principe
			Sudan	Chad
			El Salvador	Togo
			Syrian Arab Republic	Tajikistan
			Thailand	Tanzania
			Turkmenistan	Uganda
			Tonga	Uzbekistan
			Tunisia	Vietnam
			Ukraine	Zambia
			Vanuatu	Zimbabwe
			Samoa	

Table 4.5b. Countries with comparative advantage in processed products (1997)

		Processed products		
High income: OECD	**High income: non OECD**	**Upper middle income**	**Lower middle income**	**Low income**
Australia	Andorra	Argentina	Armenia	Côte d'Ivoire
Belgium-Luxembourg	Antigua and Barbuda	Bulgaria	Azerbaijan	Kenya
Czech Republic	Bahamas, The	Belize	Bosnia and Herzegovina	Kyrgyz Republic
Denmark	Barbados	Brazil	Bolivia	Madagascar
Spain	Cyprus	Chile	Colombia	Niger
France	Estonia	Costa Rica	Djibouti	Chad
United Kingdom	Trinidad and Tobago	Cuba	Dominican Republic	Zimbabwe
Greece		Dominica	Georgia	
Hungary		Grenada	Guatemala	
Ireland		Croatia	Honduras	
Iceland		Jamaica	Morocco	
Italy		St. Kitts and Nevis	Moldova	
Netherlands		Lebanon	Macedonia, FYR	
New Zealand		St. Lucia	Nicaragua	
Portugal		Lithuania	Peru	
United States		Latvia	Paraguay	
		Poland	Sudan	
		Turkey	El Salvador	
		Uruguay	Thailand	
		South Africa	Ukraine	
			Vanuatu	
			Samoa	

In 2007 there were 16 high income OECD countries with comparative advantage in processed products, but the Czech Republic and Iceland were replaced by Austria and Canada (Table 4.6b). The European Union, as a single exporter, also has a comparative advantage. There were marginal changes to the numbers and composition of countries with comparative advantage in the other income groupings. However, a total of 12 low income countries (five more than in 1997) gained comparative advantage in agriculture.

Segregating the EE countries from the income groupings, in 1997 each has a comparative advantage in agriculture except for China, while only Brazil and South Africa have a comparative advantage in processed products. This did not change over time (see OECD, 2011 for details).

The information suggests that comparative advantage in processed products is concentrated relatively more among high income countries even as the number of emerging economies with a comparative advantage increased. These are the products that comprise the largest share of agricultural trade, and they are the products with the greatest transformation or value added. Thus they potentially increase economic activity beyond the farm gate stimulating employment and economic growth along the food chain.

It also seems to be the case that even though there are many countries exporting a variety of products, trade is dominated by the few with a comparative advantage, especially among the high income OECD countries and the upper middle income countries with the most productive firms producing food beverages and tobacco. Almost 90% of the processed products exported by high income OECD countries in 2007 are from the 16 countries with an overall comparative advantage in those goods. For upper middle income countries the share exported by the 22 countries with a comparative advantage is even higher at 91% of the total from this group. In the other income categories, the countries with an overall comparative advantage are less dominant, accounting for less than half of each group's exports. A visual representation of country's export share of world processed products and its RCA value in 2007 is shown in Figure 4.7 for the top twenty exporters. The twenty leading exporting countries accounted for almost three quarters of world's total and only three of the top exporters had an RCA value below 1.

The information suggests that although a country's comparative advantage may change over time, tipping from having to not having or *vice versa*, comparative advantage, for the vast majority of countries, the pattern is fairly consistent. A country either has or has not comparative advantage whether due to its natural resource endowment, labour force, infrastructure, proximity to markets or a combination of factors. Domestic and trade policies undoubtedly also play a role although results for the EU members with same policies but different outcomes suggests that policies may be secondary to the other forces. The information also suggests that many emerging economies, including many low income countries have a comparative advantage in agriculture and this is manifested in an increasing share of world agricultural trade. But, low income countries share of agricultural trade is small and their comparative advantage may indicate an even smaller share of total merchandise trade.

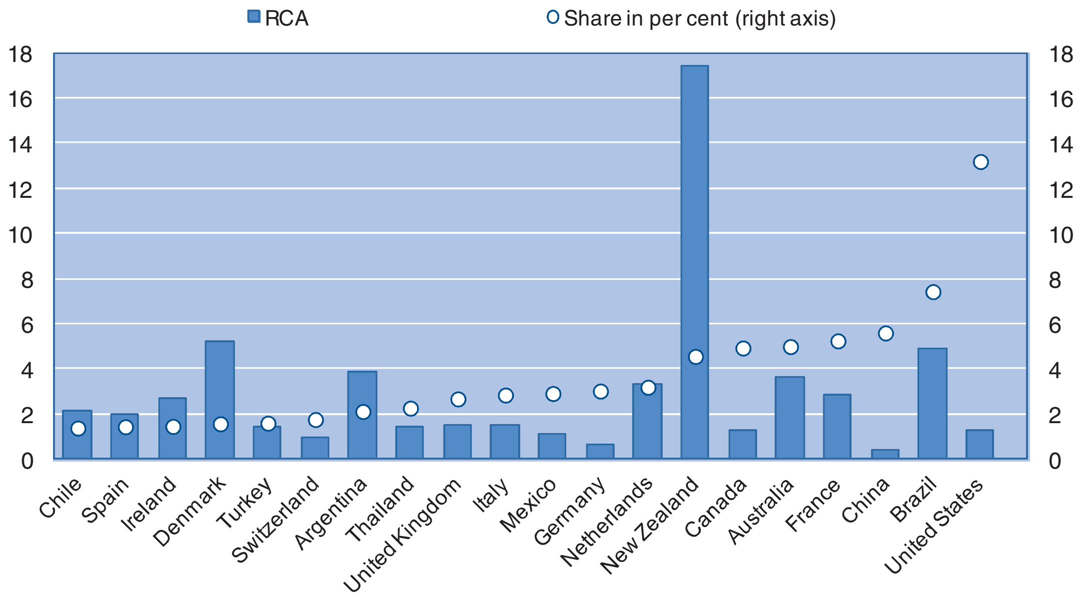
Table 4.6a. Countries with a comparative advantage in agriculture (2007)

Agriculture				
High income: OECD	**High income: non-OECD**	**Upper middle income**	**Lower middle income**	**Low income**
Australia	Barbados	Argentina	Armenia	Afghanistan
Belgium-Luxembourg	Cyprus	American Samoa	Bolivia	Burundi
Canada	Estonia	Bulgaria	Bhutan	Benin
Denmark	French Polynesia	Belarus	Cameroon	Burkina Faso
Spain		Belize	Colombia	Central African Republic
France		Brazil	Cape Verde	Côte d'Ivoire
Greece		Chile	Djibouti	Comoros
Hungary		Costa Rica	Dominican Republic	Eritrea
Ireland		Cuba	Ecuador	Ethiopia
Iceland		Dominica	Egypt, Arab Rep.	Ghana
Netherlands		Fiji	Georgia	Gambia, The
New Zealand		Grenada	Guatemala	Guinea-Bissau
Portugal		Croatia	Guyana	Haiti
United States		Jamaica	Honduras	Kenya
		Lebanon	Indonesia	Kyrgyz Republic
		St. Lucia	India	Lao PDR
		Lithuania	Jordan	Madagascar
		Latvia	Kiribati	Mali
		Mauritius	Sri Lanka	Myanmar
		Malaysia	Morocco	Mozambique
		Panama	Moldova	Malawi
		Poland	Macedonia, FYR	Niger
		Suriname	Nicaragua	Nepal
		Turkey	Peru	Pakistan
		Uruguay	Paraguay	Papua New Guinea
		St. Vincent and the Grenadines	Sudan	Rwanda
		South Africa	El Salvador	Senegal
			Syrian Arab Republic	Solomon Islands
			Thailand	Sierra Leone
			Timor-Leste	Somalia
			Tonga	São Tomé and Principe
			Tunisia	Togo
			Ukraine	Tajikistan
			Vanuatu	Tanzania
				Uganda
				Uzbekistan
				Vietnam
				Zambia
				Zimbabwe

Table 4.6b. Countries with a comparative advantage in processed products (2007)

Processed products				
High income: OECD	**High income: non-OECD**	**Upper middle income**	**Lower middle income**	**Low income**
Australia	Bahamas, The	Argentina	Armenia	Benin
Austria	Barbados	Bulgaria	Bosnia and Herzegovina	Côte d'Ivoire
Belgium-Luxembourg	Cyprus	Belarus	Colombia	Kenya
Canada	Estonia	Belize	Dominican Republic	Kyrgyz Republic
Denmark	French Polynesia	Brazil	Ecuador	Niger
Spain	Slovenia	Chile	Egypt, Arab Republic	Nepal
France	Trinidad and Tobago	Costa Rica	Georgia	Senegal
Greece		Cuba	Guatemala	Somalia
Hungary		Dominica	Guyana	São Tomé and Principe
Ireland		Fiji	Honduras	Togo
Italy		Croatia	Jordan	Uganda
Netherlands		Jamaica	Morocco	Zimbabwe
New Zealand		St. Kitts and Nevis	Moldova	
Portugal		Lebanon	Macedonia, FYR	
United Kingdom		St. Lucia	Nicaragua	
United States		Lithuania	Peru	
		Latvia	Paraguay	
		Mexico	El Salvador	
		Poland	Syrian Arab Republic	
		Turkey	Thailand	
		Uruguay	Ukraine	
		South Africa	Samoa	

Figure 4.7. Export share of twenty top exporters of processed products and their RCA value in 2007



Correlation between comparative advantage in agriculture and in processed products

How are the values of revealed comparative advantage for agriculture and processed products related to each other and to some general indicators of factor endowment and trade facilitation? Simple correlations were run between RCA values for agriculture and processed products for all countries and time periods. The resulting correlation coefficient .38 indicates a positive but not very high relation. For the two selected years 1997 and 2007, the correlation coefficient of .26 and .38 suggest that the positive relationship has increased over time.

For each income group, the correlation between the calculated RCA in agriculture and processed products was positive and it increased between 1997 and 2007. The highest correlation coefficient was for high income OECD countries with a score of .94 in 1997 increasing somewhat to .96 in 2007 suggesting almost a one to one relationship; high RCA values for processed products are associated with high RCA values for agriculture. Interestingly, the correlation coefficient between high RCA values in agriculture with high RCA values in processed products diminishes as the income level falls. Low income countries have the lowest correlation coefficient with a 2007 value of .27. This confirms the finding that many more low income countries have comparative advantage in agriculture but not in processed products indicating that many have not yet made the transition to higher valued agricultural exports.

Correlation with selected trade facilitation proxies

Recognizing the large diversity of countries in the sample, correlations coefficients were estimated for each of the selected years disaggregating the countries by income classification and adding selected variables to proxy endowments such as agricultural land as a per cent of land area (to control for overall geographic size), agricultural value added (AVA), manufacturing value added (MANVA), gross domestic product (GDP), all measured in current USD, and to control for economic size, are expressed on a per capita basis. It may also be interesting to examine the correlation between border procedures in exporting countries and their RCA. What is the correlation between indicators of trade facilitation measures such as simplification of customs procedures and RCA values? Corruption or lack thereof, may also affect a country's export firms possibly increasing the trade costs and thus affecting a country's RCA. The correlation between RCA and Transparency's International corruption perception index is also examined.

For the more than 160 countries with data in 2007, an exporter in the average country needed to have almost seven different documents in order to export with a range of as few as three and as many as 13, while needing almost 26 days before the container could cross the border (ranging from a low of five days to as many as 102 days), facing an average cost to export the 20-foot container of USD 1 231 (with a range of USD 390 to USD 4 867).[11]

The addition of the proxy variables for endowments, trade facilitation and corruption restricts the observations to 130 countries and only for 2007 because data for the selected trade facilitation are not available prior to this time.[12] The results discussed below, due to the lower number of observations are not strictly comparable to the previous results presented above. For example the correlation between RCA values for agriculture and processed products for the 130 countries in the sample is .32 compared with .38 for the full sample.

The results present a mixed picture. For the high income OECD countries, high RCA values for agriculture or processed products are positively and strongly correlated with abundant agricultural land. The correlation with the other indicator variables is much weaker. There is a positive correlation with per capita value added in agriculture and with GDP, but a negative relationship to value added in manufacturing although the values are low indicating little relationship. The correlation between trade facilitation and the computed RCA index is also relatively weak. The number of documents and the cost of getting a 20-foot container ready to export are positively related with the RCA index which is not expected. In contrast, the number of days required to export is negatively related to the RCA index suggesting that speedier exports are associated with higher RCA values. One would expect that smoother trade facilitation, lower costs and fewer documents along with shorter duration to be associated with higher RCA values, i.e. a negative relationship. The reader is reminded that the trade facilitation indicators are for all exports and are not specific to exports of processed products and that there is no causation implied by the relationship. There may be something particular about exporting processed products such as health and sanitary standards that are correlated with more documents for high income countries high RCA values. This is something that requires further investigation. Interestingly, the corruption perception index is positively correlated with the RCA index suggesting that good governance as indicated by perceived corruption is associated with higher RCA values.

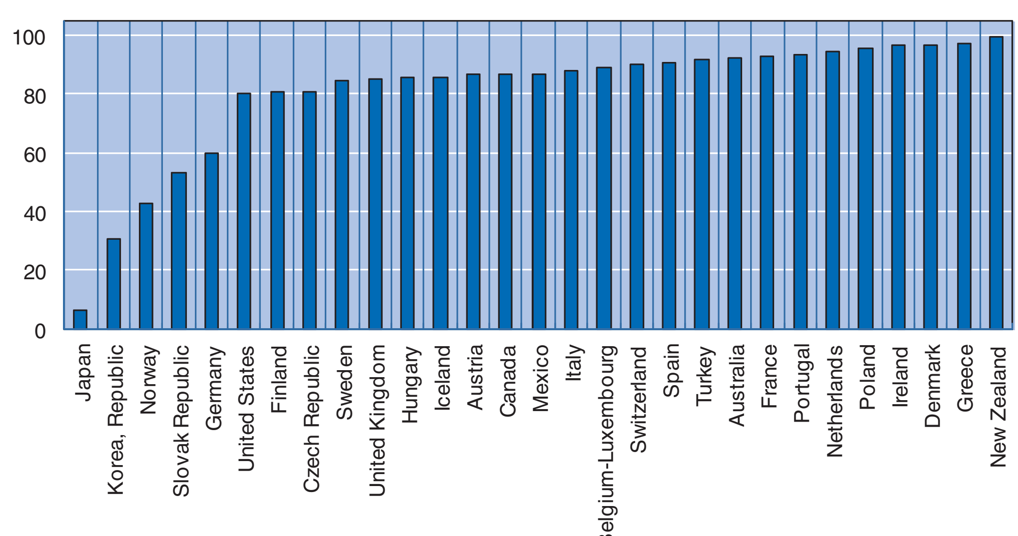
The results suggest that the correlation between RCA values in agriculture and processed products with the various variables examined is independent from income classification. In most cases, the correlation is very weak. The notable exception is the negative relationship between RCA values and the three trade facilitation variables for lower middle income countries. This is the only grouping of countries where higher RCA values are associated with fewer documents to export, lower costs and fewer delays which is what one would expect for all countries. For the grouping of low income countries, the group with relatively more countries with high RCA value in agriculture, a surprising finding is the negative relationship between AVA and RCA values. It seems that low income countries with high RCA values have relatively smaller agricultural sector much like the countries in the other income classifications. Interestingly, this is the only grouping of countries with a positive relationship between value added in manufacturing and RCA indicating that processed (food beverage and tobacco) products represent a larger share of the manufacturing sector of these countries[13].

Even though products with RCA greater than one are a minority in the export basket of most countries, they represent the vast majority of each country's exports as can be seen in Figure 4.8, the value of exports of products with RCA greater than 1 in 12 OECD countries accounted for more than 90% of their total exports whereas in only three cases did these represent less than half of total exports (Japan, Korea and Norway). As indicated above, non-high income countries export fewer products to fewer markets. Nonetheless, Figure 4.8 shows that products with RCA greater than 1 represent more than 90% of the export value for the majority of the countries except in the case of the low income group where that was the case in only 20 out of 49 countries. In the case of the EE countries, Brazil's products with RCA greater than one accounted for more than 90% of her exports, while in each of the other EE countries, products with comparative advantage accounted for at least 60% of total exports (Figure 4.8).

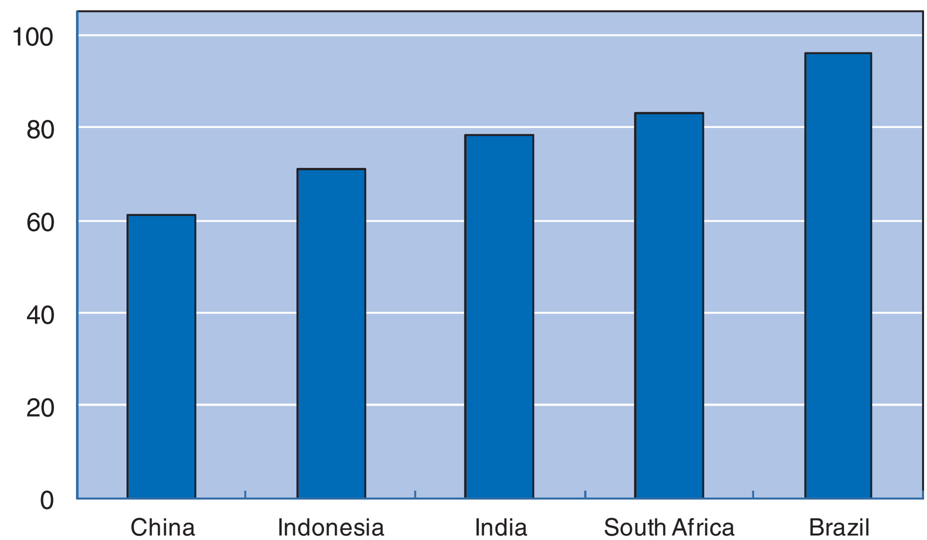
At the rather disaggregate HS-6 digit level, the results presented above indicate that the RCA index adequately identifies individual goods in which countries have a comparative advantage. The data also show that although countries with comparative advantage have a more diverse export basket and trade with more partners than others, it's the case that most of their export earnings are from exports of a smaller subset of products. However, the data also reveal that many firms export goods that appear not to have a comparative advantage. Obviously, the fact that these goods are being imported implies that exporting firms are identifying niche markets satisfying a need for a given quality and price. An interesting question is what are the characteristics of such goods and do firms acquire sufficient scale overtime to transform them into goods with a comparative advantage?

Figure 4.8. Share of exports accounted by HS-6 digit products with RCA index > 1

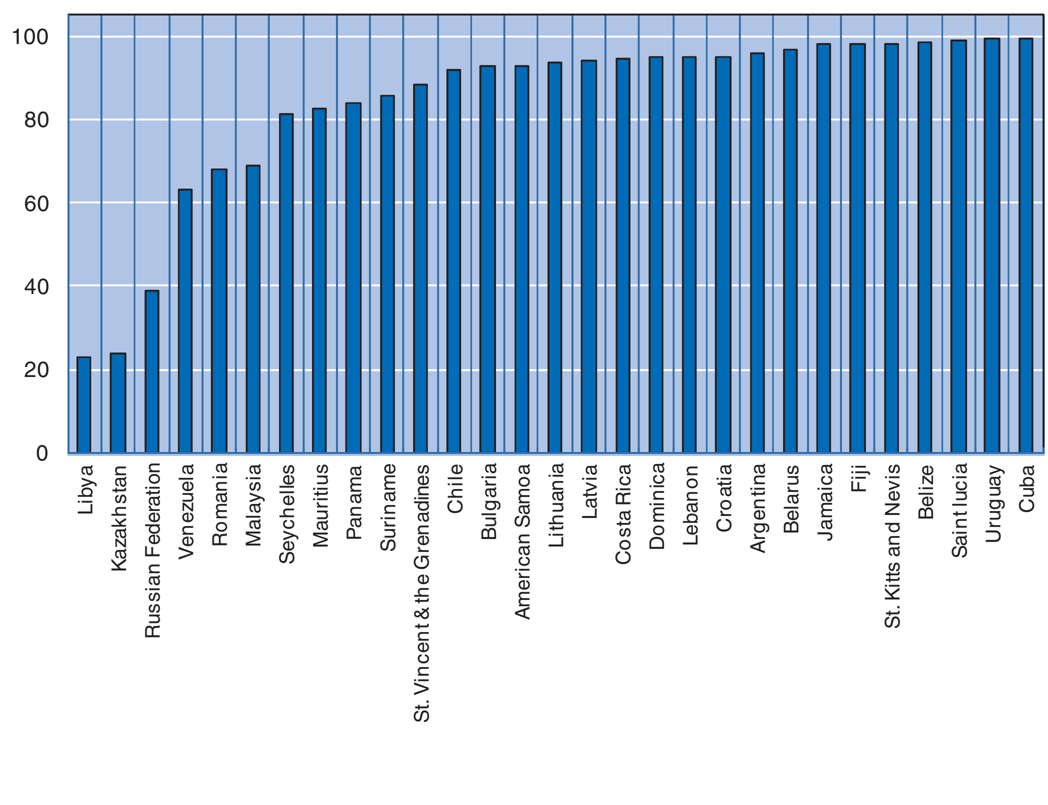
A. OECD countries



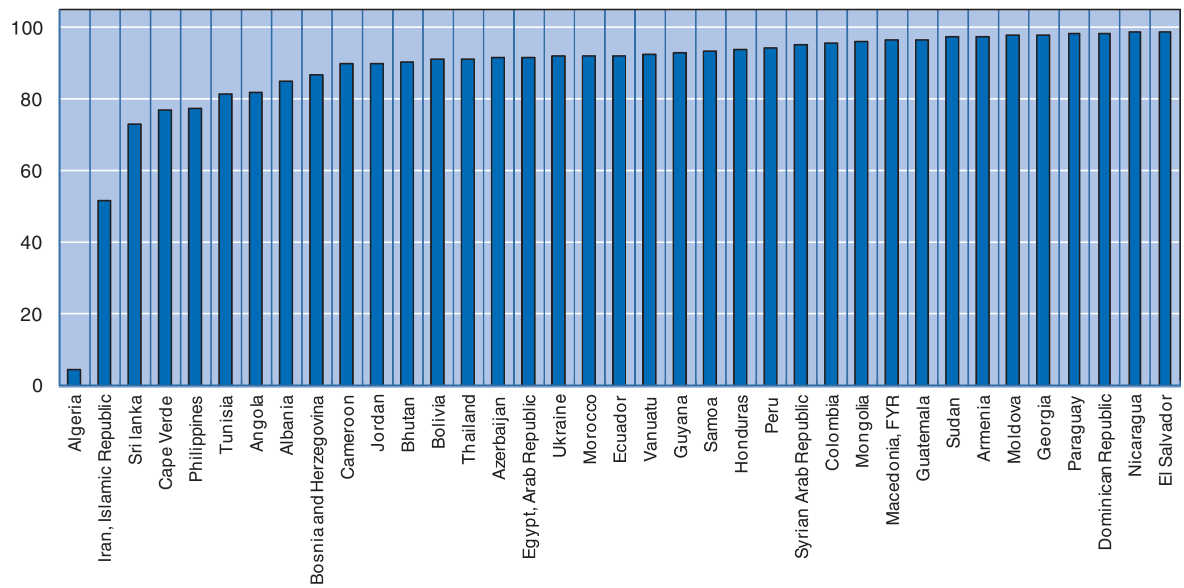
B. Enhanced Engagement countries



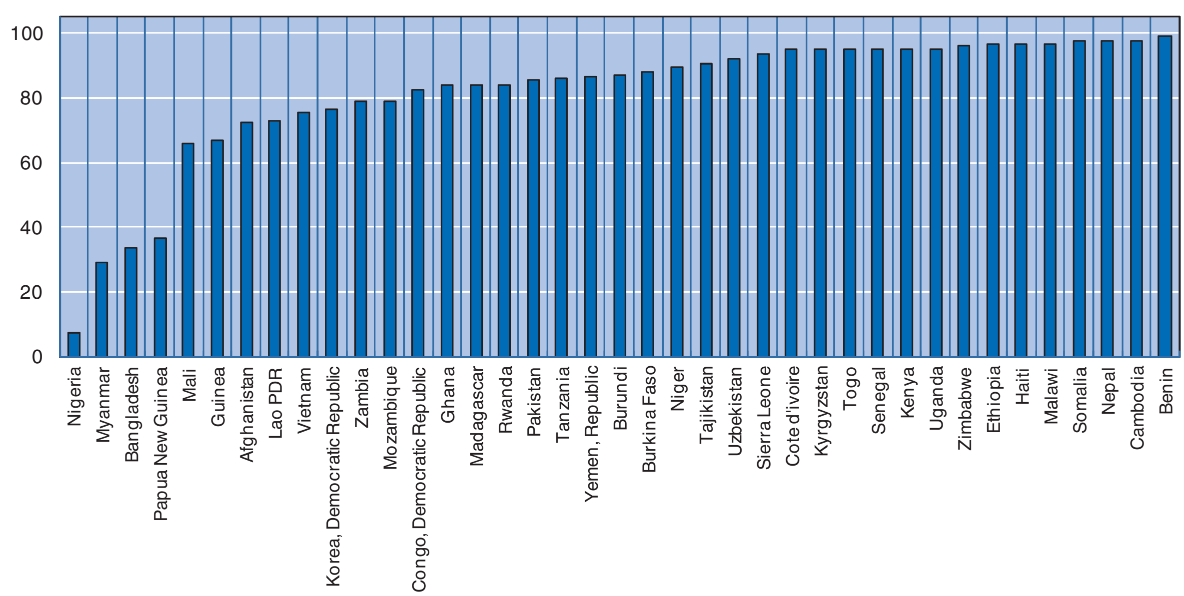
C. Selected upper middle income countries



D. Selected lower middle income countries



E. Selected low income countries



Does what you export matter?

The evidence suggests that countries produce and export a variety of processed products but specialize in a minority of these as evidenced by the RCA index. Focusing on total merchandise trade, Hausmann, Hwang and Rodrik (HHR) (2007) argue that specialization patterns are partly indeterminate and may be shaped by idiosyncratic elements. They argue that fundamentals such as endowments of physical capital, labour and natural resources along with the overall quality of institutions play an important role but do not uniquely determine what a country will produce and export. They argue that not all goods are alike in their impact on economic growth. Specializing in some products brings higher growth than specializing in others. This is related to the cost of discovering new products and the asymmetric information which turns successful products into social gains (through imitation by others) while product failures are private costs. In their setting, the range of goods that an economy produces and exports is not only determined by usual fundamentals but also by the number of entrepreneurs that are engaged in discovery. The larger the number, the closer the economy is to its productivity frontier. For agricultural products a case can be made that fundamentals such as land endowment and physical location play a critical role in determining what can be produced. Coffee, bananas, or olives for example, require special climatic conditions and cannot be produced everywhere. Processed products on the other hand share characteristics with other manufactured products.

For the empirical application of their model, HHR (2007) develop a quantitative index that ranks traded goods in terms of their implied productivity. This measure is constructed by taking a weighted average of the per-capita GDPs of the countries exporting a product where the weights reflect the revealed comparative advantage of each country in that product. Using Balassa's RCA index and per capita income Y_j, we generate an income/productivity level (coined PRODY by HHR) for each processed product (k) at the HS-6 digit level.

$$PRODY_k = \sum_j RCA_{jk} * Y_j$$

Goods that are exported by "rich" countries (controlling for overall economic size) get ranked higher than goods exported by "poorer" countries. In addition, the income/productivity level corresponding to each country's export basket is generated by calculating the export-weighted average of the $PRODY_k$ for that country. This index coined EXPY by HHR, ranks traded goods in terms of their implied productivity level reflecting the income-productivity level corresponding to that country's export basket or specialisation pattern.

$$EXPY_j = \sum_k (x_{jk} / X_j) * PRODY_k$$

Where (x_{jk} / X_j) is product *k*'s share of country *j*'s total exports.

Using total merchandise trade data from 2001 to 2003 for a consistent set of reporting countries HHR calculated average PRODY for each product. This was then used to construct the EXPY variable for all countries reporting trade data from 1992 to 2003. They find that human capital and country size (proxy by population) are positively associated with EXPY and that EXPY increases growth; a 10% increase in EXPY boosts growth by half a percentage point.

Is there a similar relationship between the productivity level of processed products, the resulting EXPY and growth? In this section the HHR methodology is employed to ascertain the relationship between a country's export productivity basket and subsequent income growth.

In order to maximize the number of reporting countries (observations) in each year the average productivity level of the various goods is calculated for 2001-2003, a period when most countries reported trade and per capita income in all three years. HHR used the RCA index as an indication of the relative importance of a product in a country's export basket and to minimize the possibility of small trade flows biasing the calculations. But the RCA index at a disaggregated level can generate extreme values that can also bias the results. For example, even though the average RCA for processed products is a little more than three during 2001-2003, RCA values greater than 2 500 can be found. To reduce the bias from such extreme values, RCA values greater than 31 are excluded from the calculations (this eliminated 1 070 observations reducing the number of observations from 65 957 to 64 887) and lowering the variance from more than 1 000 to 12.

Table 4.7 contains the average productivity levels of non-agricultural products, all agricultural products and processed agricultural products with per capita income measured in current USD (as are the trade data) and constant USD 2000. The results are not substantially different hence most of the discussion is based on per capita income measured in constant USD 2000. As in HHR, we find a large variation in the calculated PRODY suggesting that the income level associated with each traded commodity varies widely and that specialisation patterns are dependent on per capita income and this seems to hold for non-agricultural as well as agricultural products. The average productivity level for processed products is the highest supporting prior findings that they are mostly exported from high income OECD countries, but they also exhibit the largest variation.

Table 4.7. Average productivity level of individual products (2001-2003)

	Variable	Observations	Mean	Standard deviation	Minimum	Maximum
Non-agricultural products	Mean prody, current USD	4341	12 359	15 533	467	626 364
	Mean prody, constant USD 2000	4341	11 565	14 466	455	550 999
All agricultural products	Mean prody, current USD	668	12 837	17 148	890	316 906
	Mean prody, constant USD 2000	668	12 073	16 429	794	305 995
Processed agricultural products	Mean prody, current USD	254	14 352	20 796	1 643	316 906
	Mean prody, constant USD 2000	254	13 452	20 120	1 440	305 995

The productivity level of the export basket based only on processed products is given in Table 4.8 with a graphical representation calculated in current and constant USD in Figure 4.9. Even though the productivity level of individual processed products is high, the resulting productivity level of a country's export basket is low reflecting the relatively small share of processed products in the export basket of most wealthy countries. On average, EXPY increased over time reaching its maximum in 2002 but has declined since that time. Since the productivity level is held constant as explained above, this implies that more processed products are exported by poorer countries a finding which is consistent with the trends described above. The minimum values close to zero reflect countries with trivial exports of processed products compared to their overall exports.

Table 4.8. Average EXPY for processed products (constant USD 2000)

	Observations	Mean	Standard deviation	Minimum	Maximum
1996	209	421	644	0.5	4 527
1997	213	409	635	0.0	4 671
1998	210	468	823	0.2	7 967
1999	208	383	567	0.3	4 067
2000	214	387	586	0.2	4 008
2001	216	437	741	0.1	6 133
2002	215	490	964	0.1	9 081
2003	219	438	612	0.2	4 524
2004	218	377	535	0.0	4 655
2005	222	464	774	0.1	4 945
2006	217	405	679	0.0	4 938
2007	218	362	580	0.2	5 145

How does EXPY vary across countries? Figure 4.10 shows a scatter plot of EXPY against per capita GDP in 2007. The graph illustrates a relatively weak correlation between these two variables, a finding very different from HHR. The correlation coefficient between the two ranges from .21 to .34 depending on the year. Findings reported above indicate that the correlation between RCA and income is relatively low, while the results here suggest that the productivity or sophistication of a country's export basket and its income are also weakly correlated. Rich and poor countries tend to export similar products. This, however, may be a reflection of the data. Although the data are the most disaggregate on an internationally consistent basis they may still be too coarse to detect quality or sophistication differences that may be more apparent at a more disaggregate level.

Which countries have the largest and smallest EXPY? In 2007, New Zealand was the leader followed by Uruguay (Table 4.9). The list of the leading EXPY countries in Table 4.9, countries with high productivity export baskets, is surprising since it consists mostly of small island states that are not major exporters. Among the leading EXPY countries, only New Zealand and Denmark are among the top 20 exporters in 2007 while Uruguay is the 37th largest exporter while Anguilla is number 137. The resulting rankings are a result of different circumstances in each case. For example, New Zealand's and Uruguay's export basket consist of a large variety of process products while in Anguilla's case, her export basket comprises of 24 different products, one of which represents a third of total exports. For each of these countries however, processed products are a large share of their total export basket – 41% for New Zealand, 29% for Uruguay and 38% for Anguilla.

Figure 4.9. Variations of EXPY over time

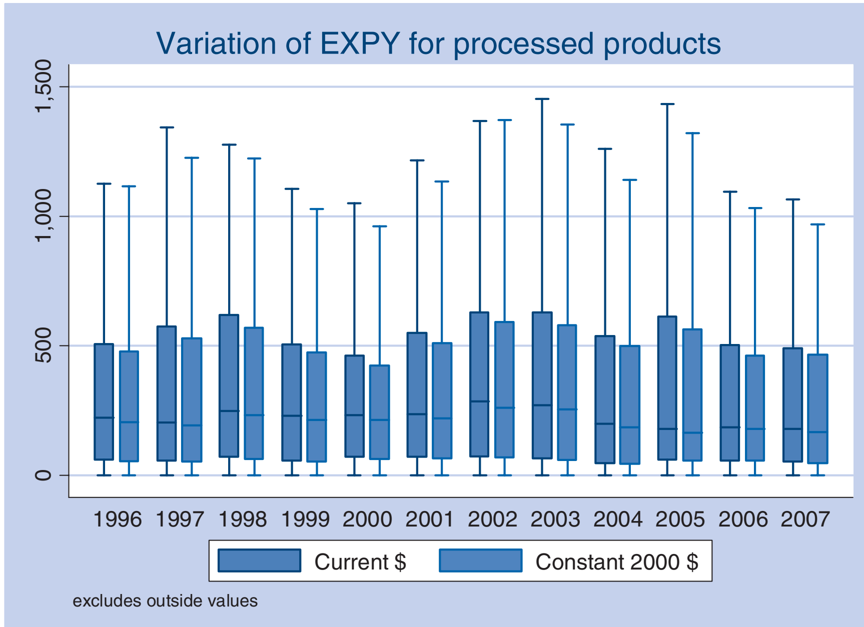
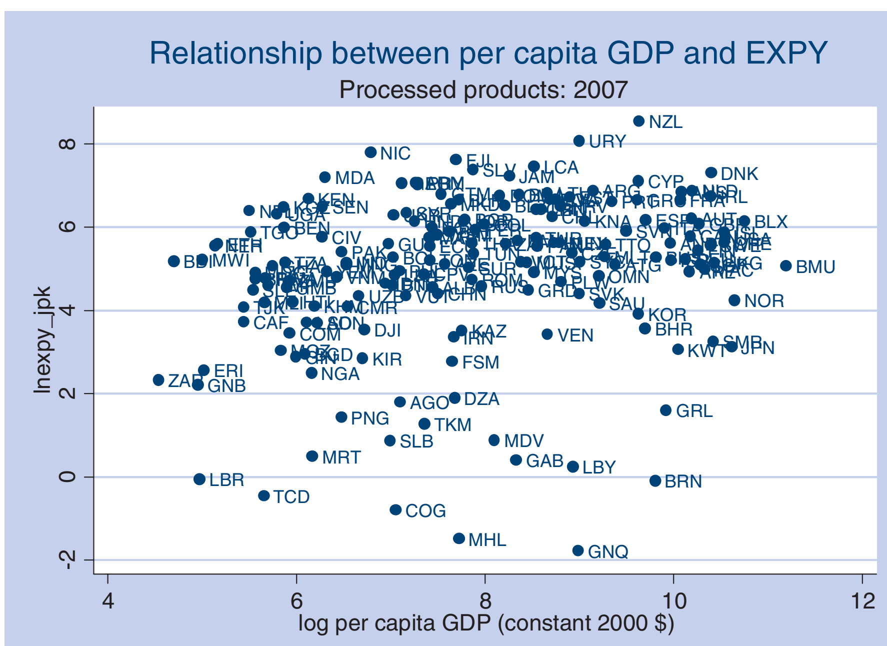


Figure 4.10. Per capita income and EXPY in 2007



The list of countries with the lowest EXPY includes those countries with trivial amounts of exports of processed products as indicated above. As mentioned in the trade patterns section, few countries dominate exports. In 2007, exports from 123 countries contributed less than 1% of the world total with 100 of these countries exporting less than USD 100 000 while another 23 exported less than USD 100. Excluding those countries to reduce outliers, the calculated EXPY values at the bottom end of the spectrum are rather low. Chinese Taipei has the lowest EXPY value, but the list of low value EXPY countries includes China, Japan and South Korea that are major exporting countries (Table 4.9). In the case of Chinese Taipei, even though her export basket consists of 207 products, many of which have high PRODY values, processed products are insignificant with a share of total exports of less than 0.2% resulting in very low EXPY. Similar results hold for China, Japan, and the other countries on the list. It seems that EXPY captures important differences in export composition of the various countries even among those exporting similar products at comparable overall levels.[14]

Table 4.9. Highest and lowest EXPY in 2007
(constant USD 2000)

Country	EXPY	Country	EXPY
Largest ten	**USD**	**Lowest ten**	**USD**
New Zealand	5 144.94	China	81.37
Uruguay	3 206.77	Norway	69.87
Anguilla	2 858.15	Saudi Arabia	65.26
Nicaragua	2 456.31	Korea, Republic	50.23
Fiji	2 037.02	Kazakhstan	33.39
St. Lucia	1 754.94	Venezuela, RB	30.72
Cuba	1 721.67	Iran, Islamic Republic	28.91
El Salvador	1 607.69	Japan	22.68
Denmark	1 501.63	Kuwait	21.41
Barbados	1 461.92	Chinese Taipei	16.79

HHR suggest that the specialization patterns and economic growth is driven not only by fundamental factors such as size of labour force and human capital but also by diversification of investment into new products. They find that controlling for per capita GDP, a 10% increase in EXPY increases growth by half a percentage point. What is the relationship between the income content of processed products exports and growth? Controlling for per capita agricultural value added, we find that a 10% increase in EXPY increases growth by four-tenths of a per cent (Table 4.10). Given that the agricultural sector (much less only processed products) is a relatively small share of most countries economies, the small order of magnitude is not surprising. The negative relationship between initial per capita AVA and growth probably reflects the fact that countries with relatively high per capita AVA were already exporting most products reducing the number of opportunities to discover new products. This negative relationship is not just for processed products. HHR in their examination for all merchandise trade also found a negative relationship between initial per capita GDP and growth. Adding the land-labour ratio to account for factor endowments (among the fundamental contributions to growth) does not alter the results (column 2 Table 4.10). Although the estimated coefficient is not significant, its presence does not affect the other estimates which remain robust. HHR interpret this result as an indication that EXPY affects growth in its own right and is not a proxy for a country's factor endowments. However, the result should be considered carefully due to the relatively short time period covered.

Table 4.10. Income content of processed products exports (EXPY) and GDP growth

	(1)	(2)
Dependent variable: growth rate of GDP per capita 1996 to 2007		
Log of initial per capita AVA	-0.050**	-0.048**
	(0.022)	(0.024)
Log of initial EXPY	0.004***	0.004***
	(0.001)	(0.002)
Log of agriculture land to labour ratio		0.003
		(0.015)
Constant	0.073**	0.068*
	(0.030)	(0.036)
Observations	153	151
Adjusted R-squared	0.078	0.069

Robust standard errors in parentheses.

*** p<0.01, ** p<0.05, * p<0.1.

Conclusions

Countries with comparative advantage, regardless of their income classification, have more diversified export profile, exporting more goods to more destinations than the average country in their income group. At the individual product level, countries export many products but have comparative advantage in only a minority of them. Nonetheless, these are the products that generate the bulk of their export earnings. The majority of high income OECD countries have a comparative advantage in processed products perhaps reflecting their large and productive food beverages and tobacco sectors. Countries with comparative advantage in processed agricultural products not only export greater volumes, they also export a greater variety of products offering their customers greater choice while also servicing more partners.

Correlations between revealed comparative advantage in processed products and proxy variables for factor endowments and trade facilitation were rather weak suggesting little relationship among the variables. The correlation between lack of corruption or cleanliness and RCA is positive and among the largest values found although still below .4 in all cases.

The profile of the products with comparative advantage is important for income growth. Using the methodology from HHR (2007), the productivity of individual processed products and countries were computed. The computed average productivity level of processed products was higher than other agricultural products and non-agricultural goods. Comparative advantage is linked to the productivity level of a country's export basket. The results indicate that a 10% increase in the productivity level of a country's processed products exports increases income by 0.04%. For lower income countries this implies that policies promoting productivity gains while also developing an export profile resembling the export basket of wealthier countries promote growth.

Notes

1. Senior Agricultural Policy Analyst, Trade and Agriculture Directorate, OECD, Paris. Material presented in this chapter is based on the work declassified by the Joint Working Party on Agriculture and Trade of the OECD and published as *OECD Food, Agriculture and Fisheries Working Papers No. 47.*
2. See OECD (2011) for the HS concordance of the four categories.
3. See Regmi *et al*. (2005) for more details on the rationale for the product classification scheme.
4. Data prior to 2006 is not available.
5. More details and some summary statistics are available in OECD (2010b).
6. Growth rates are calculated by the least square method.
7. Because trade data in the early years for Belgium and Luxembourg are grouped together, they are reported as one throughout the report.
8. In this and other cases, the reader is reminded that data for lower income countries in 2008 may not be representative because of fewer reporting countries.
9. Calculations for the European Union are based on 25 members in 2006 and 27 members as of 2007.
10. The calculated RCA for any country should be interpreted with caution as the measure not only reflects fundamental economic factors but also domestic and trade policies.
11. For the interested reader, details are reported in OECD (2011) Table 4.A5.
12. Additional trade facilitation variables such as efficiency of custom clearance process or other measures of logistic performance from the World Bank could not be used nor indicators of public corruption because observations were not available for 2007. Hence the corruption perceptions index from Transparency International for 2007 is used.
13. Details, including calculated RCA values at the individual product level and are available in OECD (2011).
14. More details can be found in OECD (2011) especially Figure A3 which shows that countries across the various income groups export products with similar productivity content with some lower income countries having relatively high EXPY and some high income countries having relatively low EXPY.

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Chapter 5

Have changes in factor endowments been reflected in trade patterns?

by
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and Anna Jankowska[1]

This chapter measures trade flows in terms of their factor content to determine if this approach still has relevance for understanding trade flows. It first discusses the Heckscher-Ohlin theory, given its focus on explaining trade in terms of a country's relative factor content. The chapter goes on to briefly examine trends in relative endowments among OECD and selected emerging economies before turning to issues of measurement. Finally, an analysis of the United States and China factor content of trade, shows how the inclusion of intermediate imports affects relevant trade balances. The chapter concludes by offering some policy considerations.

This chapter measures trade flows in terms of their factor context to determine if this approach to measuring trade still has relevance for understanding trade flows. It first discusses the Heckscher-Ohlin theory, given its focus on explaining trade in terms of a country's relative factor content. This chapter then briefly examine trends in relative endowments among OECD and selected emerging economies before turning to issues of measurement. Finally, an analysis of the United States and China factor content of trade, compares how the inclusion of the factor content of intermediate imports affects relevant trade balances. The chapter concludes by offering some policy considerations.

The Heckscher-Ohlin theory of international trade

The Heckscher-Ohlin theory of international trade states that comparative advantage is derived from differences in relative factor endowments across countries and relative intensities with which factors are used across sectors.[2] A country will have an advantage, *vi-a-vis* other countries, in producing goods in those sectors which use factors it holds in relative abundance. Vanek (1968) formalised the link between factors used in the production of a country's goods and services and its trade by comparing the relationship between those factors embodied in a country's production versus those embodied in its consumption. This has become known as Heckscher-Ohlin-Vanek (HOV) model of international trade.

The HOV model has been subject to extensive empirical scrutiny with an uneven record of success. The problem is that the lack of a clearly differentiated framework relating endowments and trade makes it impossible to test HOV against a well-specified alternative. Thus, researchers have been focusing on what version of a constantly evolving HOV model best fits the data. Starting with Leontief (1953) through Trefler (1995), HOV failed most major empirical challenges.[3] Trefler (1995) found that the measured net factor content of trade using a HOV framework is essentially zero, calling this the "case of the missing trade." He then developed a specification, allowing for home bias in consumption and international technology differences, that successfully fit the data. However, Gabaix (1997) showed that this improved model is based on a set of carefully chosen specifications and when the estimated parameters are tested to see if they successfully reconcile the predicted with the measured factor content of trade, no real improvement is observed.

Work following Trefler began to focus on why HOV models performed so badly. Measurement error tended to be the most common explanation – factors are not well defined or are not captured well enough in the value of trade (Fisher and Marshall 2008); significant aggregation bias existed in measures of trade used (Feenstra and Hanson 2000); incorrect assumptions were being made regarding returns to scale (Antweiler and Trefler 2002) and difference in technology (early examples include Trefler and Zhu, 2000; Hakura, 2001; and Davis and Weinstein, 2001). Romalis (2004) showed that transport costs and monopolistic competition are important determinants of the structure of trade and need to be incorporated into the HOV framework. In the end, what this body of work showed was that by improving specifications and including more realistic elements of trade, the HOV framework performs well.

Davis and Weinstein (2003) observe that the study of factor content has "become a laboratory to test" ideas about how the elements of endowments, production, consumption and trade fit together in a general equilibrium framework. They suggest that while great progress has been made, a deeper consideration of intermediates inputs, demand side issues (i.e. the differences in patterns of total domestic consumption of final goods and services by a country, otherwise known as "absorption"), and the role of aggregation biases is needed. This last point is echoed in Feenstra and Hanson (2000) who found evidence that the factor content of exports differs systemically from domestic production and that as disaggregation increases, the factor content of skill intensity in US trade rises. Reimer (2006) and Trefler and Zhu (2010), two attempts to directly include traded intermediate inputs into the picture, find that accounting for imported intermediates helps reconcile some apparent contradictions in observed trade patterns. More recently, Reimer (2011) estimates the role of global supply chains in the factor content of trade. He finds that, on average 21.5% of imported labour is actually domestic in origin, 17.7% of imported capital domestic in origin, 12.3% of exported labour is foreign in origin, and 23.3% of exported capital is foreign in origin.

In the end the HOV framework properly measured, has been shown to successfully explain trade patterns through differences in factor scarcities, or on the flip side, factor abundance, between economies. Thus, for our purposes, it remains a useful framework for measurement and analysis. It is not the goal of this chapter to reconcile theoretical predictions from the model as there is a wide body of literature having already done this. Rather, we use this framework to examine measures of factor content across a variety of OECD and non-OECD economies, carefully incorporating improvements in the specifications of the model identified in the literature.

Trends in factor endowments

The OECD area is capital abundant, accounting for 80% of the capital available among these countries in 2005.[4] The largest capital stocks are found in the United States and Japan, followed by Germany, France, the United Kingdom, Korea and Italy (Figure 5.1a). Capital stocks grew at an average *per annum* rate of 4.5% in the OECD as a whole during the 1990-2005 period (Table 5.1), with the highest *per annum* growth rates in Chile (10.4%) and Korea (7.7%). By comparison, in the selected emerging markets (SEM) area capital is relatively scarce. These countries held roughly 20% of total capital measured in 2005 with the largest capital stocks held by China, India, and Brazil (Figure 5.1c). China shows an especially rapid accumulation in capital stocks in the period 1995-2005 with a *per annum* rate of 11.5%, followed by India with a rate of 9.2%. Stocks of capital in the SEM area overall grew at a rate of 8.3% *per annum*, outpacing growth in the OECD (Table 5.1).

labour are found in the United States and Japan (Figure 5.2). The largest stocks in the SEMs are in China, India and Indonesia (Figure 5.2). As with capital, labour stock grew at disparate rates across these two groupings during the 1990-2005 period. In the OECD area the labour pool grew at a rate of 0.60% per annum while the SEMs increased at the considerably faster annual rate of 2.1% (Table 5.1).

Table 5.1. Capital and labour stock growth, 1990-2005

Per cent per annum

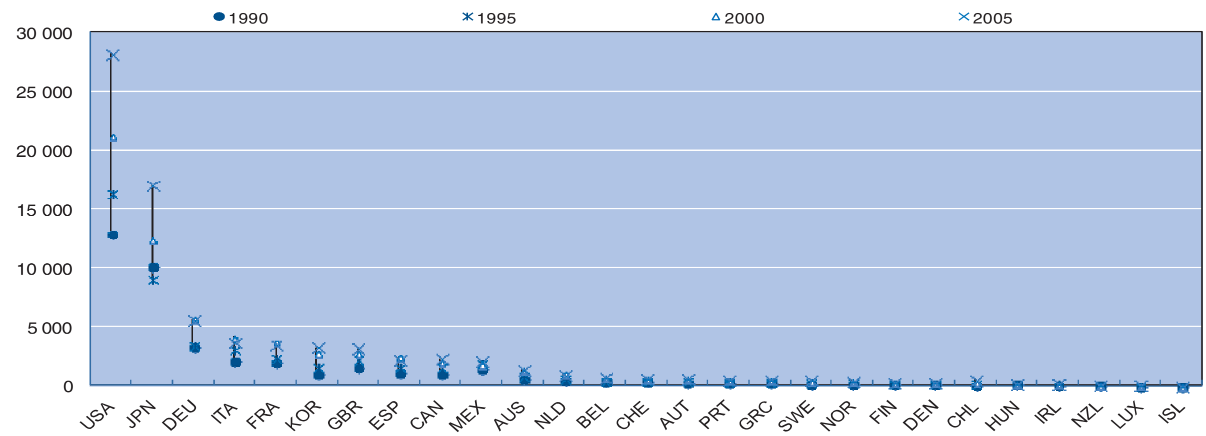
	OECD	SEM
Capital stocks	4.45	8.32
Total labour	0.60	2.11
Skilled labour	3.14	4.75
Unskilled labour	0.48	1.73

Source: World Development Indicators (WDI), International Institute for Applied Systems Analysis (IIASA), Vienna Institute of Demography (VID), authors' calculations.

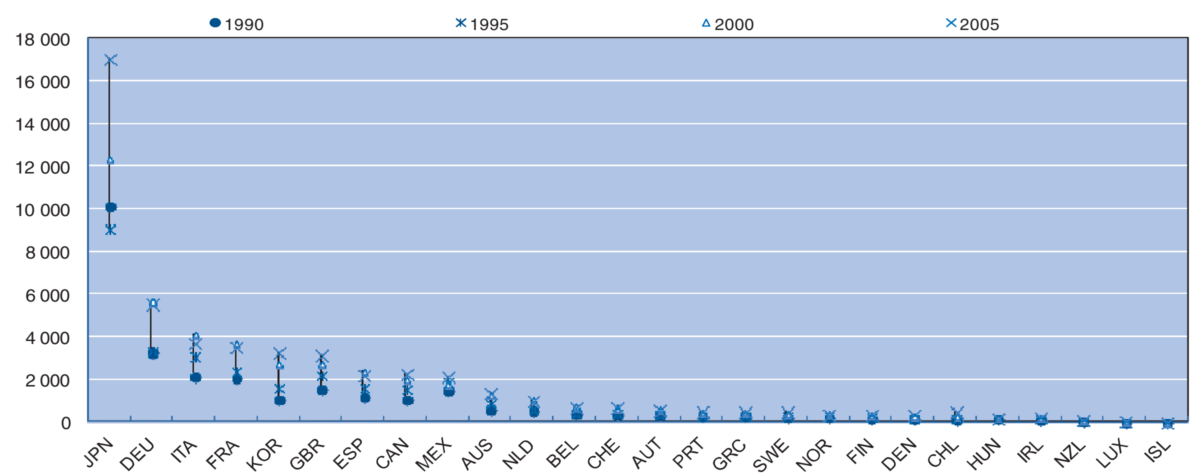
Figure 5.1. Capital stocks

In billions

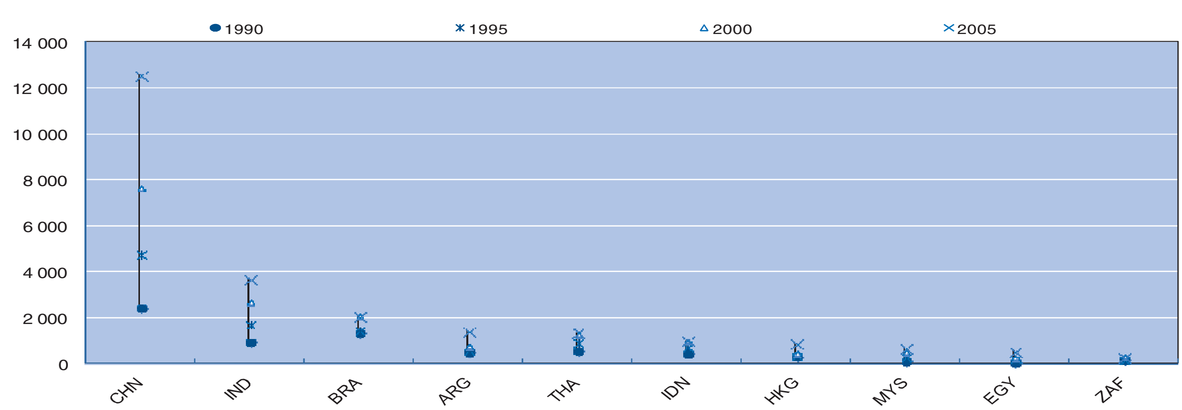
Panel A. OECD



Panel B. OECD without United States



Panel C. Selected emerging markets



Source: World Development Indicators (WDI), authors' calculations.

Conversely, labour is relatively abundant in the SEM area, which accounts for roughly 70% of labour in the total sample. Within the OECD area, the largest stocks of Decomposing by skill level reveals further differences in labour force characteristics between the OECD area and SEMs (Figures 5.3 and 5.4).[5] Overall, the 2005 total labour force breaks down into a 10% share of skilled workers[6], and 90% share of unskilled workers. The OECD countries accounted for 56% of total skilled labour force, while the SEMs held the remaining 44%. Stocks of skilled labour increased in the OECD area at a per annum rate of 3.3% between 1990-2005; more slowly than the SEMS rate of 4.8% per year in the same period. India and China held the bulk of the skilled labour stocks among the SEMs.

The OECD's share of unskilled labour was 25%, while the SEMs accounted for the remaining 75%. Unskilled labour stocks grew at a rate of 0.53% *per annum* in the OECD area, only a third as fast as the rate of 1.7% per annum in SEMs during the 1990-2005 period. The United States holds the largest stocks among the OECD countries while China and India dominate the SEMs (Figure 5.4). Thus while OECD countries continue to hold larger stocks of capital and skilled labour endowments, SEMs accumulation rates are much higher for both, indicating that relative abundance may be changing over time. This is especially true in capital and skilled labour and dominated by China and India.

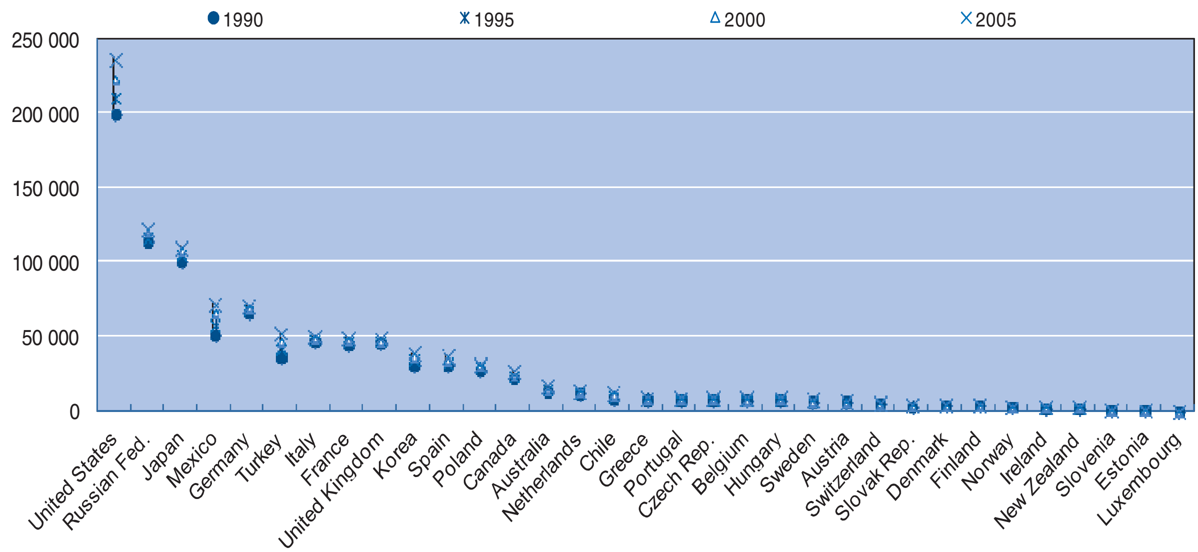
To understand how endowments play a role in a country's trade composition, it is important to understand the way these factors are used. Thus, we look at changes in the amount of capital per worker across these economies. The ratio of capital stock per worker (k/l) provides a direct comparison of factor abundance.[7] Figure 5.5 shows the k/l ratios for two selected groupings of OECD countries.[8] In line with observed changes in stocks of capital, k/l increased in all OECD countries, except Mexico between 1990 and 2005. The highest values of k/l ratios corresponded to the countries with the largest capital stocks; the United States and Japan (with Japan dominating) and the largest increases in the k/l ratio in occurred in Chile and Korea (Figure 5.5).

By comparison (Figure 5.5), the capital per worker ratios in SEMs are small, reflecting the smaller capital base relative to labour abundance in this grouping. Only Argentina and Malaysia fall within a k/l range comparable to some OECD countries. The k/l ratios in SEMs have remained relatively stable during the 1990-2005 period in China, Indonesia, and India, while decreasing over time in Brazil. The largest increases in value of k/l ratio occurred in Argentina, Malaysia and Thailand.

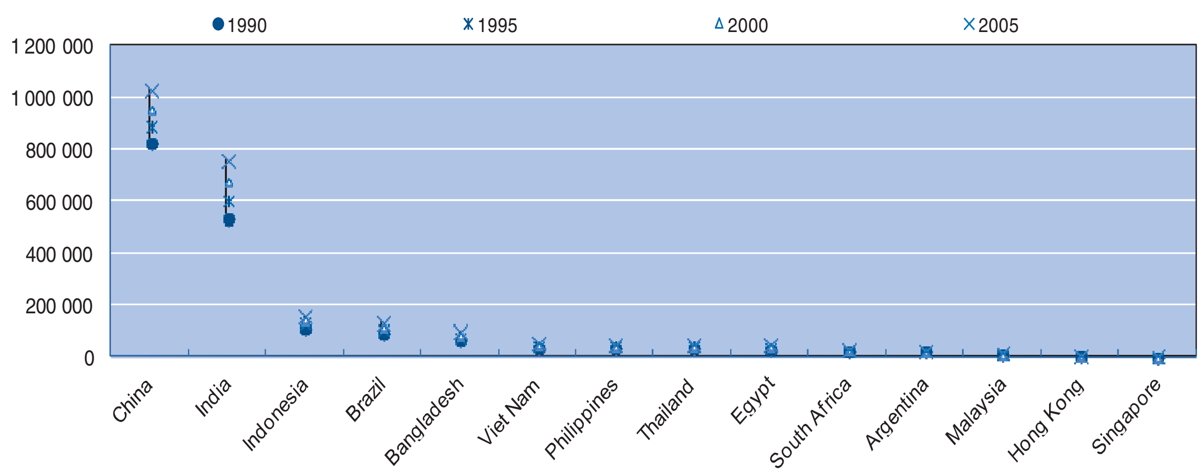
Figure 5.2. Total labour force

In millions

Panel A. OECD



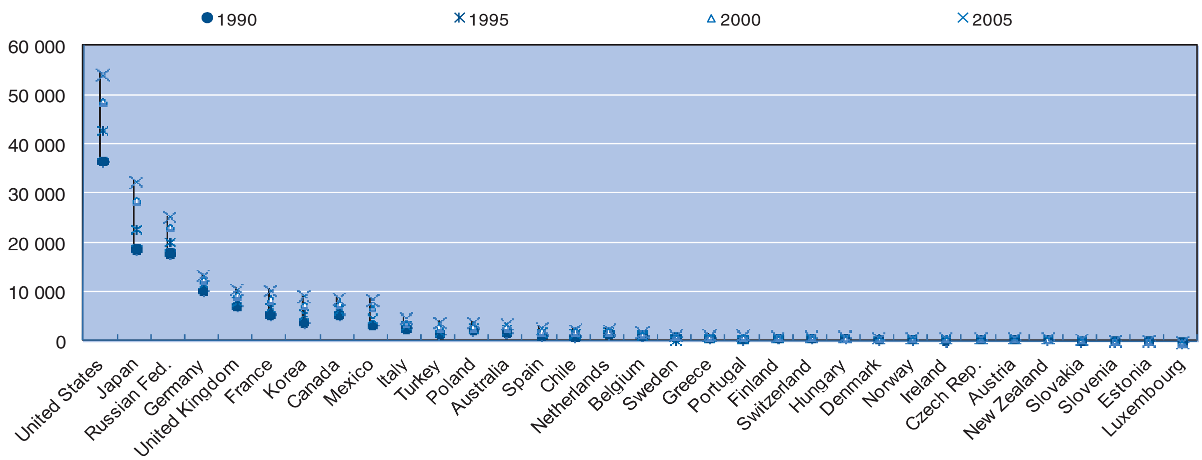
Panel B. Selected emerging markets



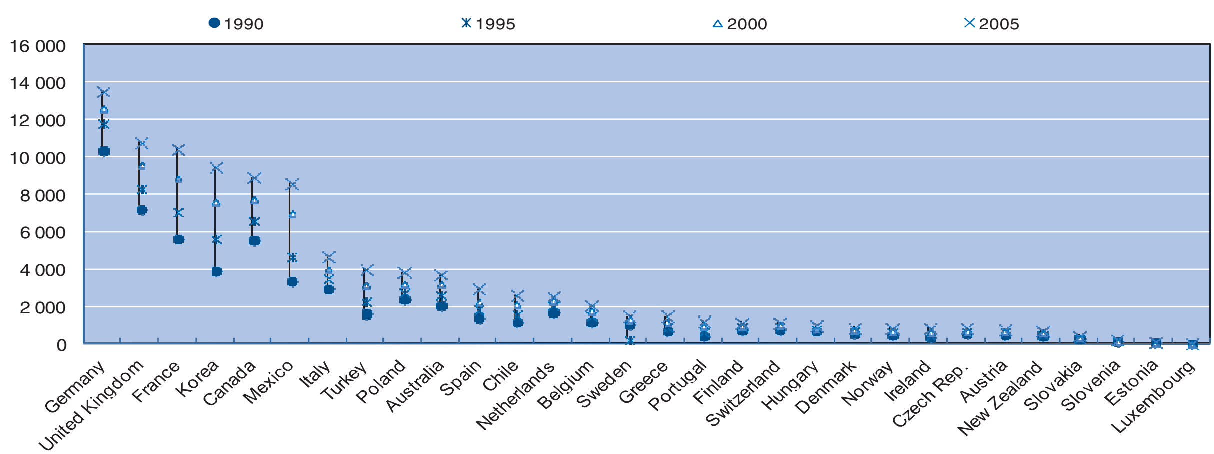
Source: International Institute for Applied Systems Analysis (IIASA), Vienna Institute of Demography (VID).

Figure 5.3. Skilled labour stocks
In thousands

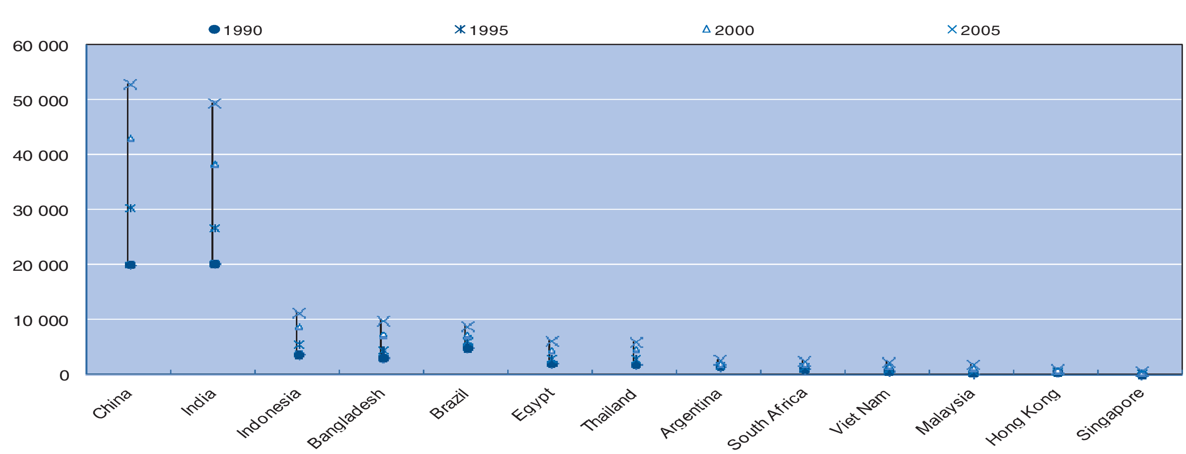
Panel A. OECD



Panel B. OECD without United States, Japan and Russian Federation



Panel C. Selected emerging markets

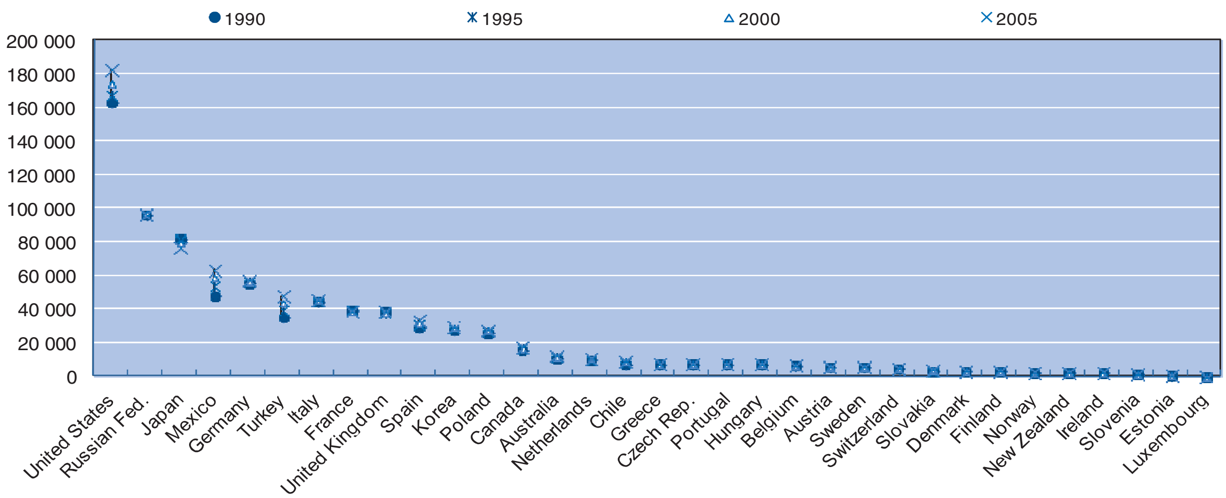


Source: International Institute for Applied Systems Analysis (IIASA), Vienna Institute of Demography (VID).

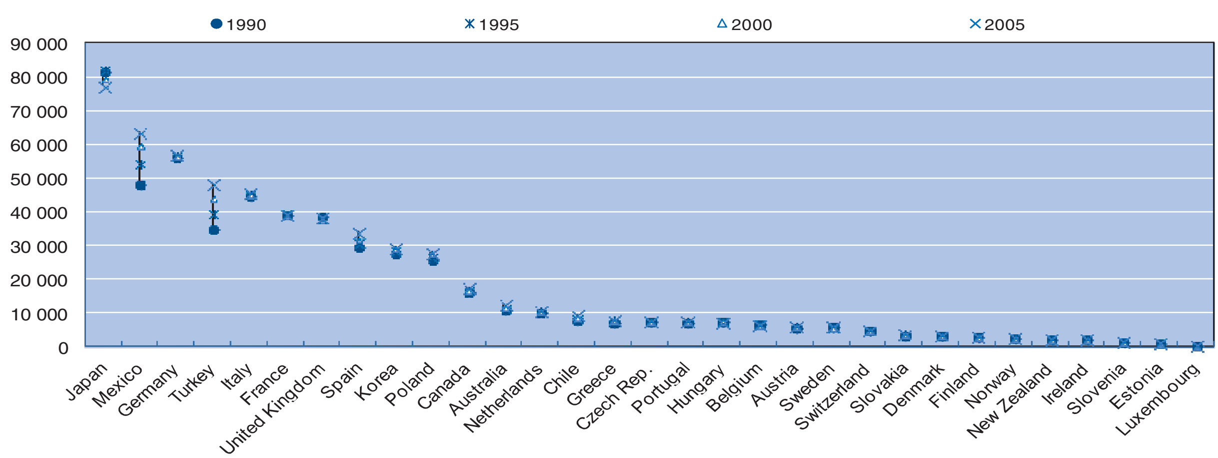
Figure 5. 4. Unskilled labour stocks

In thousands

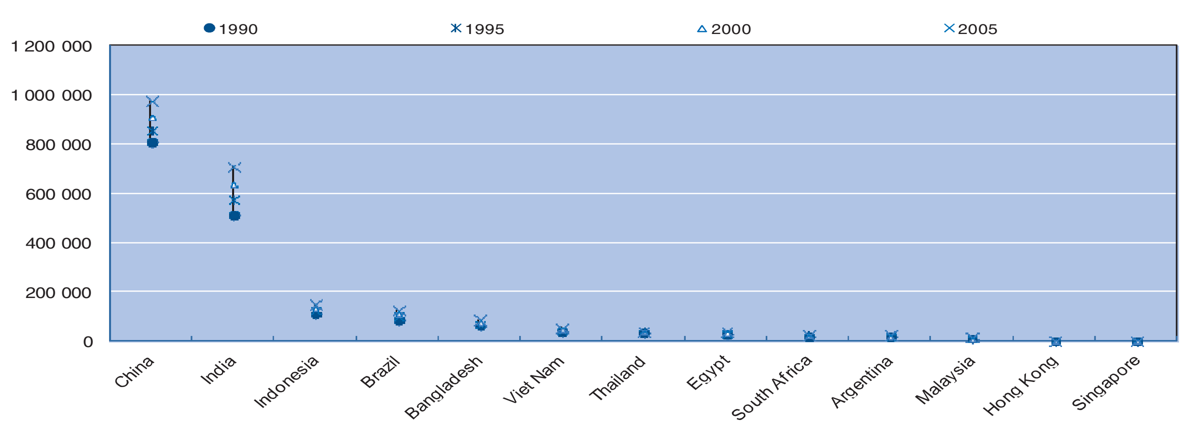
Panel A. OECD



Panel B. OECD without United States and Russian Federation



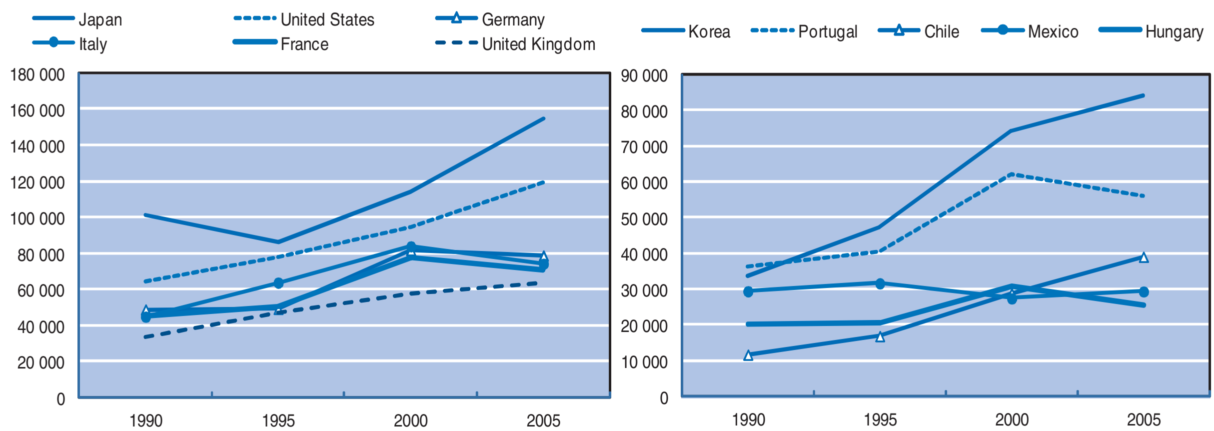
Panel C. Selected emerging markets



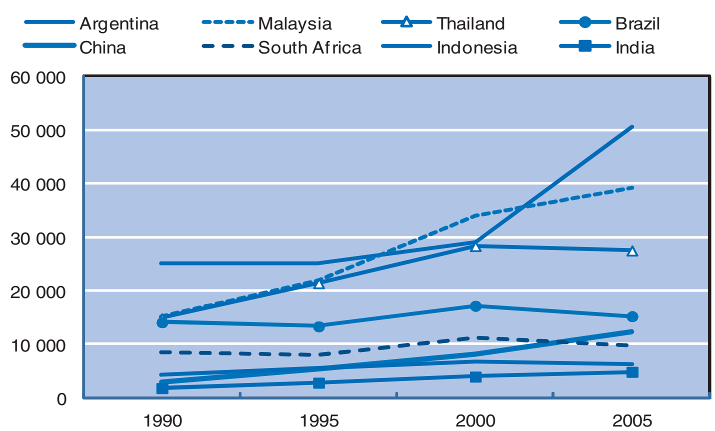
Source: International Institute for Applied Systems Analysis (IIASA), Vienna Institute of Demography (VID), 1970-2000, 2000-2050 datasets.

Figure 5.5. Capital-labour ratios

Panel A. Selected OECD countries



Panel B. Selected emerging economies



Source: World Development Indicators (WDI) for capital, and International Institute for Applied Systems Analysis (IIASA) and Vienna Institute of Demography (VID) for labour stocks, author's calculations. Ratios using WDI values for both capital and labour are qualitatively the same.

Productivity

In order to provide a broad consistent measure of labour productivity across the economy as a whole, we look at output per worker (using GDP as a proxy for output).[9] Productivity within and between the OECD and SEM country groupings vary widely (Figure 5.6). Among OECD countries, the highest ratios of output per worker are found in Luxembourg, Norway, Japan and the United States. At the lower end of the spectrum, we find newer Eastern European member states, Turkey and Chile. During the 1990-2005 period, output per worker across the OECD increased at an average per annum rate of 1.5%.

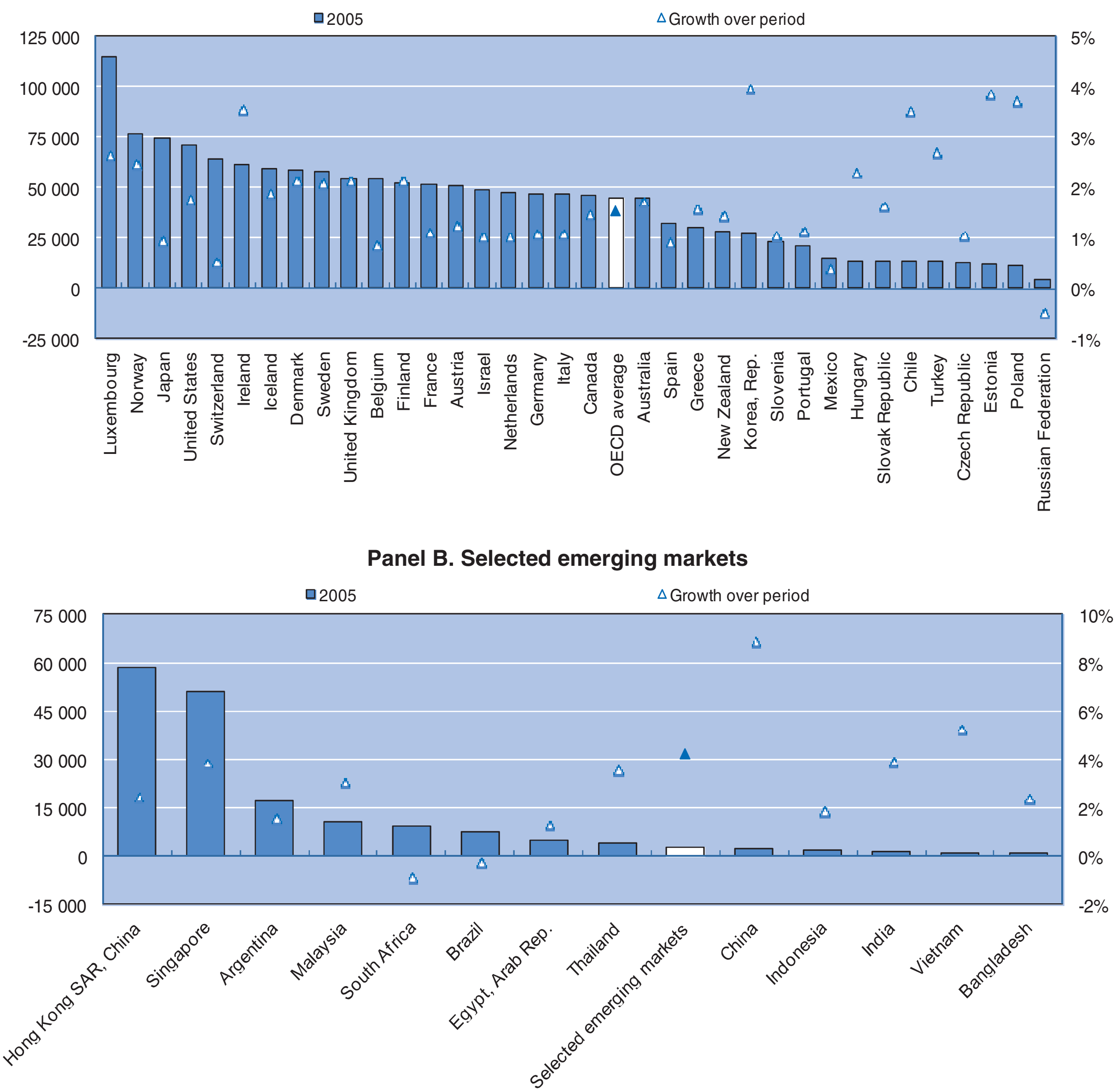
In SEMs, labour productivity remains significantly lower on average, with the exceptions of Hong Kong and Singapore (Figure 5.6). Despite this considerably lower base, productivity growth rates indicate that this is changing rapidly, at an average per annum rate of 4.2%, nearly three times faster than the OECD area. The growth was not, however, consistent throughout the grouping. Output per worker declined in Brazil and South Africa during this period.

This comparison underscores the importance of taking into account how factors are utilized and differences in technology of production in order to better understand how factor abundance influences a country's comparative advantage. For example, it has been shown that labour productivity increases with capital investment.[10] Thus, the fast growth rates of labour productivity in SEMs may be a product of the rapid increase in capital formation in these economies observed here. To see how these various, often competing forces, have played out in trade patterns, we now turn to examining the measured factor content of trade.

Figure 5.6. GDP per worker

Panel A. OECD

Panel B. Selected emerging markets



Source: World Development Indicators.

Measuring factor content

Total endowment stocks have been growing across both OECD and SEMs, with SEMs experiencing faster growth across the board. Within the OECD, skilled labour stocks grew 6.5 times faster than unskilled while the SEMs skilled labour growth rate exceeded its unskilled rate at a slower rate (2.7 times). Indeed, labour productivity continues to grow at a robust rate among OECD countries, especially in Korea, Estonia and Poland. There was also strong productivity growth in China and Vietnam among the SEMs. We now look to see how these trends are reflected in trade patterns.

We begin our construction of the factor content of trade with the simple HOV model:

$$F^i \equiv AT^i = V^i - s^i V^w \tag{1}$$

The first expression on the right hand side represents the standard HO specification: the factor content of *i*'s trade (F^i) is a function of the inputs used (A) times the country's net trade T^i. The final expression comes from Vanek (1968), who showed that the measure of factor content should equal an economy's measure of factor abundance. In this expression, V^i is a measure of factor endowments in country i, V^w is the measure of world endowments and s^i is the share of country i in world consumption. So, for example, if a country is relatively abundant in labour, the factor content of trade would be positive as the excess of what is produced with the country's labour supply, over what is consumed of labour-intensive goods, is exported. Conversely, if a country is relatively scarce in labour, the value would be negative, as it consumes a greater share of the world's labour endowment.

While previous studies have incorporated intermediates into their analysis, they have generally treated intermediate inputs as non-traded (for example Davis and Weinstein (2001) and Hakura (2001)). Reimer (2006, 2011) developed an approach allowing for internationally traded intermediate inputs in to the calculation of factor content. Theoretical proofs for such an approach were further provided in Trefler and Zhu (2010) who demonstrated the class of models that completely characterises, and are implied by, the Vanek prediction of the factor content of trade, including a traded intermediate sector. This section relies upon these theoretical developments to construct measures of factor content that account for both technological differences across country's production processes while explicitly including trade in intermediate goods that does not impose the importing country's technology, but rather allows for the producing country's choice in techniques.

Consider an economy with k factors and i goods so that the Leontief matrix is:

$$D(I - B)^{-1} \tag{2}$$

Where each column of the k x i matrix D consists of primary factor inputs and each column of the i x i matrix $(I - B)^{-1}$ captures the total intermediate inputs in the production of a good or service.[11] Proper measurement of B ensures the matrix of direct and indirect factor requirements includes all the services of k endowments. In addition, by defining each D and B matrix through each country's unique input-output structure, we capture the technological differences in production needed to completely define the factor content approach.

Referring back to the original HOV equation (1), we can restate it as follows:

$$F_k^i \equiv AT_k^i$$

with A now defined as

$$A^i \equiv D^i (I - B^i)^{-1} \tag{3}$$

and thus:

$$F_k^i = D_k^i (I - B^i)^{-1} T_k^i \tag{4}$$

Trefler and Zhu (2010) argue while several studies have applied equation (4) to measure factor content, they have not done so consistently, nor fully accounting for international technological diversification. They show the definition of factor content of trade needs to satisfy three criteria: 1) must be Vanek-relevant, that is consistent with the Vanek prediction that factor content is defined as in *(1)*; 2) the definition has a clear and useful economic interpretation; and 3) the definition does not require restrictions on the form of international choice of technology. However, arriving at such a definition of factor content when international technology matrices are allowed to vary has proven difficult.

As stated above, Reimer (2006) does allow for internationally determined and traded intermediate inputs in his model. He uses a horizontal concatenation of country-specific direct factor input matrices to construct *B* in equation (4) and thus provide an indication of how much of the world's factor *k* is embodied in *i*'s production of a good. However, Reimer's model consists of two countries: the United States and the ROW and two factor inputs, labour and capital. Thus, it does not completely specify a variety of international technological choices. As we are attempting to measure the factor content (and thus input matrices) for 44 regions and five factors of production, applying such an approach becomes unwieldy, not to mention involving the loss of a tremendous amount of detail.

Trefler and Zhu (2010) developed a more generalised approach relying on the proportionality assumption to recover a *B* matrix consistent with their three criteria. They derive an adjustment parameter, θ to recover the share of domestic consumption, including intermediates, sourced locally. [12] Thus, we are able to estimate the world trade in intermediate inputs – that is, those sourced (and produced) locally and those sourced (and produced) overseas – by defining *B* as:

$$B_j^i = B^i * \theta_j^i \tag{5}$$

Where B_j^i is the input matrix of *i* sourced from *j* and θ is defined as:

$$\theta_j^i(g) \equiv \frac{M_j^i(g)}{Q_i(g) + M_i(g) - X_i(g)} \quad \text{for all } j \neq i \tag{6}$$

Where *Q* is output of good *g* in *i*, *M* is imports of good *g* (in the numerator into *i* from *j*, and the denominator is *i*'s total imports of *g*) and *X* is the exports of *g* from *i*. Thus θ_j^i (g) is the share of domestic absorption that is sourced from country *j*. Summing over all *j* sources and subtracting from 1 provides the share of good *g* that is sourced locally.

Referring explicitly to an intermediate input matrix of dimensions *g, h* (input of good *g* into industry *h*), we define $B^i_j(g,h)$ as elements of B^i_j and $\hat{B}_i(g,h)$ as elements of $\hat{B}_i \equiv \sum_j B^i_j$. We then have:

$$\sum_{j\neq i} B^i_j(g,h) = \hat{B}_i(g,h) \sum_{j\neq i} \theta^i_j(g), \text{ (imported intermediates)}$$

$$B^i_i(g,h) = \hat{B}_i(g,h)\theta^i_i(g), \text{ (local intermediates)} \tag{7}$$

Further, a simple extension leads us to:

$$B^i_j(g,h) = \hat{B}_i(g,h)\theta^i_j(g) \text{ for all } i \text{ and } j \tag{8}$$

As expressed in equation (5), where equation (5) suppresses the (*g,h*) reference to industries. When Trefler and Zhu (2010) applied this adjustment to data for 41 countries, focusing on labour inputs, their results show a 95% consistency rate with predicted values, as opposed to the 34% reported in previous studies.

By measuring the amount of factors used worldwide to produce a country's trade flows, we can say the factor requirements matrix for country *i*'s trade is constructed accounting for the complete production process of each good that enters into net exports and adding up the factors actually used, including those used in producing intermediate inputs overseas (Deardorff 1982). This will further allow us to analyse the role of intermediate inputs in trade, by comparing the *F* derived in equation (1) with its counterpart expressed generally in equation (4), and adjusted by (5).

The work presented here makes two distinctions over these existing measures of factor content. First, as in Trefler and Zhu (2010), we rely on individual countries' technology matrices rather than the existing approach of using a single matrix adjusted for production technology differentials. We then apply a definition of factor content that measures the amount of factors used worldwide to produce a country's trade flows, and we apply this across a set of five factors of production, including a breakout of skilled and unskilled labour. Thus we construct a more complete factor requirements matrix for a country's trade by allowing for differentiated production processes including those inputs used in producing intermediate inputs overseas (Deardorff, 1982). Finally, we apply this approach to different time periods to observe how the factor content of trade has changed. By comparing the equations derived without directly accounting for intermediate inputs with those that do, we can analyse the role of intermediate inputs in trade and the determination of a country's comparative advantage.[13]

Ranking factor content

In order to better understand the potential drivers of the factor content of trade, it is important to understand the relative factor endowment structure both within, and between, countries, and how that has changed over time. According to equation (1), net exports of a factor is positive (negative) if the country's endowment of the factor is great (lower) than its content of total domestic consumption, that is if $V^i_k - s^i V^w_k > 0$, for factor *k*. Additionally, it is possible to look at a country's relative factor abundance (each endowment relative to other endowments within a country) by examining the variables normalised by the factor content of the country's consumption. From equation (1) we can define the following:

$$c_k = V_k^w * s \tag{9}$$

where s remains the country's share of world consumption, $V^w{}_k$ is the world endowment of factor k and c_k is the content of factor k in domestic consumption (Muriel and Terra 2009). The factor abundance test can be compared across the various factors k such that:

$$\frac{V_k^i}{c_k} > \frac{V_{k'}^i}{c_{k'}} \tag{10}$$

The relationship in (10) states the content of factor k in net exports is higher (lower) than that of factor k' if factor k is relatively more abundant (less abundant); where factor contents are normalised by domestic consumption. We can also restate these values, measuring factor abundance by income rather than consumption, adjusting this value to take account of the trade balance as in Bowen and Sveikauskas (1992). To account for a country's income level (Y_i) adjusted by the trade balance (b_i) we can restate c_k as follows:

$$c_k^b = \frac{Y_i}{Y_i - b_i} * c_k \tag{11}$$

and rank each factor accordingly.

Data

To implement this approach, it is important we have access to input-output data for as complete and consistent a set of countries as possible. While the OECD input-output tables are a consistent and up-to-date set of information, they cover only a few countries outside the OECD and are limited in their factor input coverage. The GTAP database also provides a consistent measure of trade flows and input data but covers a larger number of countries globally, as well as a breakdown of skilled and unskilled labour.[14] We use three versions of the database, namely GTAP versions 5, 6 and 7 which correspond to base years of 1997, 2001 and 2004, respectively.[15] The input-output tables contain five primary factors of production: land, unskilled labour, skilled labour, capital and natural resources. Land is defined in GTAP as an agriculture-specific resource and is used only in production in these sectors. Natural resources are associated with extraction industries and are a factor input for the sectors fishery, forestry, coal, oil, gas and other mining. Labour is divided into skilled and unskilled based on the International Labour Organisations (ILO) classification.[16]

How has factor usage within a country changed over time?

As discussed above, overall labour productivity rates rose over the 1990 – 2005 time period, especially in the emerging OECD and SEM economies. In this section, we apply the factor content of trade definition to explore the relative uses of these factor endowments and how they have changed over time.

To examine a country's relative factor abundance, that is each endowment relative to other endowments within a country at a point in time, we use equation (10), or based on adjusted income levels as modified per (11). Both measures provide a relative value for factor abundance with respect to other factors within a single country.

We calculate these relative values for each country in the sample for the three time periods: namely 1997, 2001 and 2004 and rank the factors to determine the relative abundance as revealed by the country's trade position, and examine how this has changed over time. The relative factor abundance values and their rankings are presented for OECD and SEM countries in Tables 5.2 and 5.3, respectively.[17]

The two tables present three pieces of information: (1) the calculated factor abundance measure for each of the five resources, relative to the other resources within each country; (2) the rankings for each of these factors of production relative to the other factors for each of the three years; and (3) the standard deviation of the factor abundance measures for each year. As shown in the table, in all three years, the relative rankings for most OECD economies have remained consistent which means there have been no significant changes in relative factor endowments within each of these economies in the time period examined. Most OECD economies consistently rank skilled labour and capital at the top of their relative resource endowments as measured by the factor services employed. The rankings for Mexico, Chile, Hungary, Poland and Turkey show a greater reliance on land and natural resources. Australia also shows a high reliance on natural resources, but unlike the other countries listed, capital and skilled labour are also significant factors. Within their own resource structure, capital ranks first in Austria, France, Germany, Italy and New Zealand for each of the three years examined. Denmark, Sweden, Switzerland, the United Kingdom and the United States all consistently rank skilled labour as number one, relative to their other resource use. These countries show a high use of labour in general, with unskilled labour ranking second.

Despite the relative stability in rankings of endowments in OECD countries, there have been some noteworthy developments among member states. Into the 2000s, both skilled and unskilled labour moved up in ranking over capital for Australia. New Zealand experienced a small change in its endowment rankings with the role of natural resources declining and unskilled labour increasing. Korea shows an increase in the prominence of capital in place of unskilled labour while Japan's unskilled labour and capital both increase their rank relative to the use of their other resources, namely skilled labour. The increasingly significant ranking of unskilled labour in Japan (as foreshadowed by their large stock of unskilled endowment) is reflected in employment growth patterns. Between 1990 and 2009, the only employment sectors which enjoyed consistent positive growth in Japan were labourers, service workers and professional and technical workers (Statistical Bureau Office of Japan, 2010). The first two categories, which experienced the fastest growth, are dominated by unskilled workers. Spain, Poland and Hungary all saw their top ranked resource move from land in 1997 to capital by 2004.

Land and natural resources hold the dominant positions in the SEMs for each of the three time periods (Table 5.3). As with the OECD, the rankings show little movement over this time. Exceptions are Brazil and South Africa who both experienced a shift away from land and resource extraction to a greater reliance on capital and labour. In both these economies, capital was ranked the highest in 2004. All countries examined show relatively low rankings in the use of skilled labour.

Table 5.2. Factor rankings, OECD countries

		Land	Rank	Unskilled labour	Rank	Skilled labour	Rank	Capital	Rank	Natural resources	Rank	Standard deviation
Australia	1997	0.617	5	0.862	4	1.048	3	1.056	2	1.758	1	0.380
	2001	0.881	5	1.103	3	1.288	2	0.909	4	2.297	1	0.522
	2004	0.731	5	1.179	3	1.278	2	1.015	4	1.456	1	0.246
Austria	1997	0.459	4	0.888	2	0.808	3	1.197	1	0.124	5	0.370
	2001	0.560	3	0.582	2	0.545	4	1.210	1	0.136	5	0.344
	2004	0.782	2	0.642	4	0.712	3	1.117	1	0.136	5	0.316
Belgium	1997	0.248	4	1.035	2	1.186	1	0.913	3	0.045	5	0.453
	2001	0.225	4	0.907	2	1.107	1	0.877	3	0.052	5	0.416
	2004	0.287	4	0.690	3	0.846	2	1.007	1	0.213	5	0.310
Canada	1997	0.351	5	1.093	2	0.728	4	0.854	3	1.718	1	0.453
	2001	0.520	5	1.078	2	0.866	4	0.879	3	1.634	1	0.366
	2004	0.304	5	1.088	2	1.001	3	0.893	4	1.713	1	0.450
Chile	1997	1.816	1	0.796	4	0.541	5	1.351	3	1.527	2	0.470
	2001	2.321	1	0.876	4	0.608	5	1.283	3	1.625	2	0.600
	2004	1.412	1	0.989	4	0.709	5	1.354	3	1.386	2	0.277
Denmark	1997	1.024	2	0.985	3	1.153	1	0.732	4	0.510	5	0.230
	2001	0.592	5	1.152	2	1.343	1	0.774	3	0.727	4	0.282
	2004	0.595	5	0.983	2	1.217	1	0.870	3	0.855	4	0.202
Estonia	1997	..	..	..	..	..	..	..	..	..	..	..
	2001	1.361	2	1.307	3	0.859	5	0.967	4	1.436	1	0.229
	2004	0.785	3	0.906	2	0.704	5	1.312	1	0.737	4	0.222
Finland	1997	1.179	1	0.840	4	0.937	2	0.902	3	0.411	5	0.250
	2001	0.669	4	0.948	3	1.072	1	0.977	2	0.441	5	0.233
	2004	1.135	1	0.919	4	1.090	2	1.082	3	0.288	5	0.316
France	1997	0.688	4	0.768	3	0.811	2	1.068	1	0.095	5	0.322
	2001	0.568	2	0.518	4	0.565	3	1.121	1	0.090	5	0.328
	2004	0.682	3	0.624	4	0.771	2	0.944	1	0.102	5	0.283
Germany	1997	0.303	4	0.918	3	1.003	2	1.009	1	0.202	5	0.358
	2001	0.410	4	0.734	3	0.786	2	1.026	1	0.219	5	0.286
	2004	0.339	4	0.798	3	0.855	2	0.962	1	0.155	5	0.316
Greece	1997	2.807	2	1.044	4	1.053	3	0.754	5	4.834	1	1.549
	2001	1.049	4	1.228	3	1.281	2	0.814	5	5.263	1	1.676
	2004	1.361	2	0.849	4	0.879	3	1.387	1	0.298	5	0.400
Hungary	1997	1.618	1	0.823	3	0.618	4	1.155	2	0.423	5	0.422
	2001	1.607	1	0.781	3	0.562	4	1.255	2	0.318	5	0.468
	2004	1.213	2	0.768	3	0.666	4	1.229	1	0.153	5	0.398
Ireland	1997	0.694	4	0.969	2	1.107	1	0.929	3	0.257	5	0.298
	2001	0.767	4	1.093	2	1.284	1	1.074	3	0.214	5	0.375
	2004	0.754	4	0.847	3	0.903	2	1.420	1	0.221	5	0.382
Italy	1997	0.832	2	0.714	4	0.818	3	1.208	1	0.122	5	0.351
	2001	0.522	4	0.602	3	0.717	2	1.246	1	0.128	5	0.361
	2004	0.599	4	0.614	3	0.653	2	1.237	1	0.114	5	0.357
Japan	1997	0.217	4	1.092	2	1.123	1	0.976	3	0.177	5	0.428
	2001	0.221	4	1.064	2	1.071	1	0.914	3	0.190	5	0.401
	2004	0.237	4	1.111	1	1.031	3	1.089	2	0.118	5	0.443
Korea	1997	2.200	1	1.273	2	0.887	4	1.193	3	0.471	5	0.572
	2001	2.287	1	1.161	3	0.815	4	1.232	2	0.285	5	0.657
	2004	2.969	1	1.232	3	0.830	4	1.314	2	0.193	5	0.920
Luxembourg	1997	0.526	4	1.025	2	1.148	1	0.878	3	0.050	5	0.397
	2001	0.481	4	1.144	2	1.357	1	0.951	3	0.050	5	0.472
	2004	0.594	4	0.758	3	0.918	2	1.213	1	0.031	5	0.393

Table 5.2. Factor rankings, OECD countries (*cont.*)

		Land	Ran k	Unskilled labour	Rank	Skilled labour	Rank	Capital	Rank	Natural resources	Rank	Standard deviation
Mexico	1997	2.381	1	0.623	4	0.397	5	1.458	3	2.336	2	0.830
	2001	1.438	3	0.664	4	0.480	5	1.526	2	1.849	1	0.527
	2004	1.592	1	0.477	4	0.444	5	0.803	2	0.735	3	0.415
Netherlands	1997	0.302	5	0.895	3	1.011	1	0.937	2	0.588	4	0.265
	2001	0.288	5	0.647	3	0.779	2	0.972	1	0.625	4	0.224
	2004	0.387	4	0.617	3	0.768	2	1.054	1	0.344	5	0.261
New Zealand	1997	0.546	5	0.965	2	0.839	4	0.979	1	0.946	3	0.162
	2001	0.918	4	1.093	2	0.909	5	1.124	1	1.071	3	0.091
	2004	0.849	4	1.131	2	0.907	3	1.228	1	0.632	5	0.211
Poland	1997	1.762	1	0.895	4	0.635	5	0.980	3	1.501	2	0.414
	2001	1.658	1	0.831	4	0.562	5	1.048	3	1.068	2	0.362
	2004	1.048	2	0.692	3	0.542	5	1.128	1	0.666	4	0.230
Portugal	1997	1.442	1	1.016	3	1.315	2	0.659	4	0.342	5	0.408
	2001	0.657	4	1.069	2	1.409	1	0.710	3	0.338	5	0.368
	2004	0.706	4	0.861	3	0.974	2	1.024	1	0.264	5	0.274
Russia	1997	0.000	0	0.000	0	0.000	0	0.000	0	0.000	0	0.000
	2001	1.333	2	1.091	3	0.651	5	0.869	4	9.346	1	3.352
	2004	1.600	2	0.821	4	0.579	5	1.211	3	6.026	1	2.019
Slovak Republic	1997	..	..	..	..	..	..	..	..	..	..	..
	2001	1.056	2	0.715	3	0.526	4	1.465	1	0.440	5	0.377
	2004	1.266	2	0.673	3	0.495	4	1.349	1	0.232	5	0.436
Slovenia	1997	..	..	..	..	..	..	..	..	..	..	..
	2001	0.529	4	1.143	1	0.899	3	0.901	2	0.395	5	0.273
	2004	0.964	3	1.079	1	0.752	4	1.004	2	0.223	5	0.310
Spain	1997	1.153	1	0.897	4	0.942	3	1.100	2	0.423	5	0.258
	2001	0.622	4	0.826	3	0.884	2	1.163	1	0.440	5	0.245
	2004	0.680	4	0.976	2	0.971	3	1.162	1	0.166	5	0.348
Sweden	1997	0.436	4	0.967	2	1.254	1	0.627	3	0.256	5	0.361
	2001	0.292	4	0.847	2	1.080	1	0.680	3	0.277	5	0.313
	2004	0.351	4	0.672	3	0.843	1	0.823	2	0.162	5	0.270
Switzerland	1997	0.704	4	1.030	2	1.215	1	0.814	3	0.072	5	0.390
	2001	0.637	4	0.909	2	1.071	1	0.840	3	0.089	5	0.340
	2004	0.433	4	1.073	2	1.121	1	0.933	3	0.024	5	0.424
Turkey	1997	1.146	2	0.830	3	0.534	5	1.479	1	0.679	4	0.340
	2001	1.124	1	1.098	2	0.660	4	1.021	3	0.631	5	0.216
	2004	1.373	1	1.024	3	0.635	4	1.297	2	0.370	5	0.385
United Kingdom	1997	0.511	5	1.017	2	1.176	1	0.820	3	0.565	4	0.255
	2001	0.227	5	0.992	2	1.163	1	0.809	3	0.545	4	0.331
	2004	0.197	5	0.952	2	1.078	1	0.813	3	0.447	4	0.327
United States	1997	0.457	4	1.063	2	1.263	1	0.924	3	0.407	5	0.337
	2001	0.431	4	1.106	2	1.292	1	0.946	3	0.340	5	0.375
	2004	0.347	4	1.185	2	1.382	1	0.697	3	0.343	5	0.427

Source: Authors' calculations based on GTAP database versions 5, 6 and 7.1.

Table 5.3. Factor rankings, selected emerging economies

		Land	Rank	Unskilled labour	Rank	Skilled labour	Rank	Capital	Rank	Natural resources	Rank	Standard deviation
Argentina	1997	2.559	1	1.074	3	0.631	5	1.149	2	0.807	4	0.683
	2001	1.239	1	0.928	2	0.708	5	0.817	4	0.885	3	0.178
	2004	2.412	1	1.019	3	0.694	5	0.915	4	1.779	2	0.639
Bangla-desh	1997	4.907	1	1.125	3	0.541	5	0.986	4	2.244	2	1.576
	2001	5.926	1	1.348	3	0.645	5	1.025	4	2.535	2	1.922
	2004	6.934	1	1.380	3	0.624	5	1.163	4	2.058	2	2.298
Brazil	1997	1.105	2	0.946	3	0.766	4	1.125	1	0.516	5	0.228
	2001	0.695	5	0.885	2	0.841	3	0.953	1	0.741	4	0.094
	2004	0.965	2	0.898	4	0.768	5	1.034	1	0.933	3	0.088
China	1997	4.538	1	1.427	3	0.557	5	1.009	4	3.115	2	1.483
	2001	5.320	1	1.705	3	0.679	5	1.089	4	2.947	2	1.672
	2004	4.555	1	1.371	4	0.672	5	2.341	3	3.171	2	1.363
India	1997	9.398	1	0.913	4	0.321	5	1.122	3	1.408	2	3.402
	2001	10.063	1	1.169	3	0.604	5	1.094	4	1.435	2	3.605
	2004	10.688	1	1.199	3	0.569	5	1.194	4	1.324	2	3.856
Indonesia	1997	7.438	1	1.164	4	0.378	5	1.363	3	4.800	2	2.678
	2001	5.799	2	0.809	4	0.375	5	1.368	3	6.158	1	2.534
	2004	7.059	1	1.101	4	0.418	5	1.371	3	4.109	2	2.468
Malaysia	1997	5.034	2	1.035	4	0.572	5	1.796	3	5.550	1	2.080
	2001	1.240	3	1.309	2	0.664	5	1.154	4	4.631	1	1.434
	2004	1.309	2	1.243	3	0.599	5	1.211	4	4.833	1	1.519
South Africa	1997	..	..	..	..	..	..	..	..	..	..	..
	2001	0.502	5	1.166	2	0.876	3	0.849	4	2.601	1	0.732
	2004	0.425	5	0.973	3	0.828	4	1.180	1	0.998	2	0.254
Thailand	1997	3.115	1	0.404	4	0.235	5	2.233	2	1.161	3	1.099
	2001	4.317	1	0.690	4	0.434	5	1.459	3	1.499	2	1.383
	2004	4.752	1	0.682	4	0.421	5	1.591	2	1.314	3	1.558
Viet Nam	1997	4.727	1	0.967	4	0.466	5	1.194	3	4.139	2	1.768
	2001	6.324	1	1.183	4	0.466	5	1.317	3	4.359	2	2.240
	2004	8.165	1	1.314	3	0.634	5	1.039	4	6.031	2	3.072

Source: Authors' calculations based on GTAP database versions 5, 6 and 7.1.

A notable difference between the two country groupings is in the standard deviation of the abundance measure. This measure provides some insights in the changing endowment structure and the relative intensities with which resources are used within each economy examined. The more dominant one or two resources are in terms of their relative intensity, the greater the spread in values among the resources and the greater the standard deviation. Thus, it is interesting to see if these values have changed over the three time periods examined.

We see countries like France, the United Kingdom and Germany with small and fairly constant measures of standard deviation, implying the relative intensity of factor usage has changed little over the three time periods. Greece and Russia exhibit large standard deviations implying dominance in a specific resource – in Russia's case natural resources. Greece's standard deviation declined significantly in 2004 as capital and labour began to play a greater role in its economic activities diversifying away from natural resources. Interestingly enough, the United States shows a slightly increasing standard deviation among its factor measures while its actual rankings remain stable. This is due to an increasing use of labour relative to that of capital. Mexico and Chile, on the other hand, experienced a decline in their standard deviation. For Mexico, there was a relatively small change in the use of labour and capital across its economic activities while for Chile the use of labour increased relative to that of capital. What is interesting for Chile is that while the relative rankings of the two labour and capital measures do not change, the relative abundance measure shows a convergence in the intensity of usage.

Among most of the SEMs, there is much greater variation within each country's resource ranking as shown by the standard deviations. The exceptions are Brazil, which has the lowest standard deviation of all economies reported here, and South Africa whose measure substantially declined in 2004. This implies that Brazil has employed the five resources measured here with relatively equal intensity in each of the three time periods. Thailand's standard deviation has increased as evidenced by the large and increasing factor abundance measure for land. This would imply that agricultural products are taking a larger role while capital usage shows a relative decline. India remains dominated by its land usage as does Indonesia. However, Indonesia's factor abundance measures for land and natural resources have declined somewhat indicating a potential increase in the diversity of other resources used.

What the above discussion highlights is a relatively stable factor abundance story for most of the advanced OECD countries.[18] However, the dynamics of changing market structure are evident, as illustrated by the changing ranks and growing dispersion of relative factor abundance measures in, for example, the United States and South Korea. Chile, Mexico and Poland show decreasing variation among measures of factor abundance which could imply, as revealed by factor abundance measures, established production patterns. Turkey, on the other hand, shows increasing dispersion potentially indicating a changing relative factor base.

SEMs, for the three time periods examined, show a relatively consistent factor ranking, still heavily dependent on land (i.e. agricultural) and natural resources. However, movement to capital goods can be observed in the case of Brazil and to a lesser extent, Indonesia. Most countries continue to show a factor endowment story related to agriculture and natural resources.

Overall, these results are consistent with those observed in factor endowment trends. The stability in both groups of countries' rankings is a possible reflection of the large established factor stocks in these economies. That is, the large share of capital and skilled labour stocks in the OECD and the unskilled labour stocks in the SEMs. However, the small shifts in rankings and the changing abundance measures, along with their standard deviations, show an emerging trend of diversification into using capital and skilled labour for SEMs and a subtle shift in the OECD endowment usage as well.

How has factor content of trade changed over time?[19]

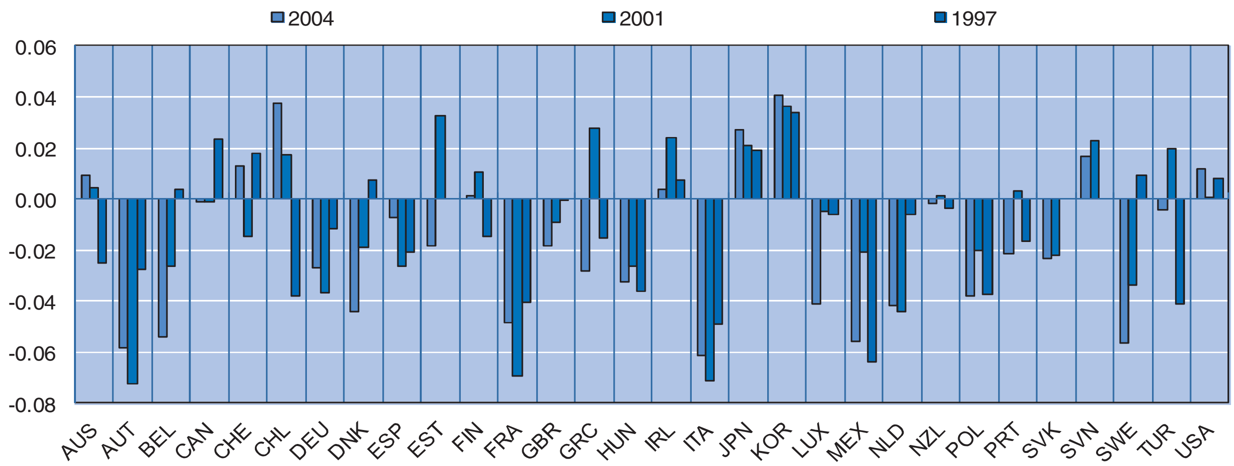
We calculate a measure of factor content for each of the five GTAP factors for the three time periods (1997, 2001 and 2004) based on a derivation of the basic equation shown in (1) and presented in the Figures 5.7 and 5.8.[20] Positive values are an indication of a comparative advantage as implied by exporting abundant factors of production, while a negative value reflects a negative factor content of trade.

For ease of discussion, we present a measure of factor content of trade for three factors: skilled labour, unskilled labour and capital, for OECD economies (Figure 5.7) and SEMs (Figure 5.8). As expected, most of the OECD countries show a deficit in unskilled labour (panel 1). The notable exceptions are Japan and Korea who have surpluses in each of the three years, as do, albeit to a lesser extent, Australia, Chile, Finland, Ireland, Slovenia, Switzerland, Estonia, Turkey and the United States. This outcome is consistent with the rankings of relative factor abundance presented in the previous discussion. For example, the United States and Japan had the highest OECD stocks of unskilled labour and both show labour in general (skilled and unskilled) as a consistently ranked highly utilised resource relative to the other resources used. A notable exception is Korea. Its unskilled labour stocks were not significantly higher than other OECD countries, showing a trade deficit in this factor (France, for example) yet its relative factor usage ranking for unskilled labour was behind both land and capital in 2001 and 2004 (Table 5.2). However, broadly speaking these results do reflect the patterns observed in the factor endowment trends noted above.

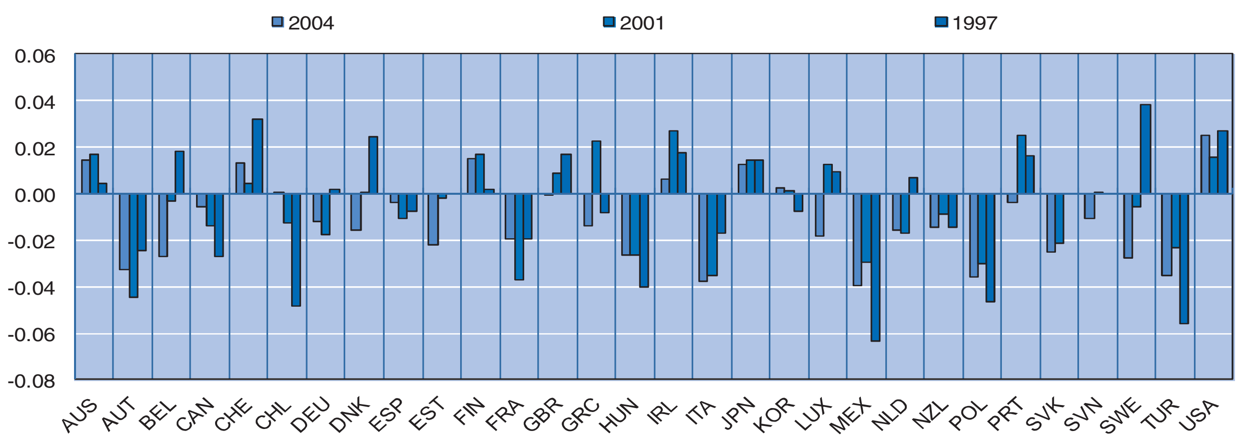
The highly positive values for both Japan and the United States in its factor content of skilled workers shown in the following panel is again a reflection of the abundance of labour reported for these countries. France, Italy and Germany, among others, are all shown to have deficits in their factor content of trade in skilled workers. This is in fact surprising as most OECD countries have a relative abundance of skilled workers *vis-a-vis* the rest of the world and skilled labour ranks as Italy and Germany's second most intensively used resource (Table 5.2). However, where these countries show a consistent comparative advantage is in the area of capital, where all three have relatively large positive values (France, excepting in 2004). Mexico's increase in capital stock and its associated increase in relative usage rank are reflected in its positive factor content of trade for capital. This trend is observed despite Mexico's falling k/l ratio which is more a reflection of faster labour growth than declines in capital stock. While the measure experienced a downturn in 2004, it was strongly positive in 1997 and 2001. Other countries with factor content surpluses in capital include New Zealand, Ireland and Chile and the newly emerging OECD economies of Poland, Hungary, Slovenia, Estonia and Turkey.

Figure 5.7. Country level measures of factor content, OECD countries

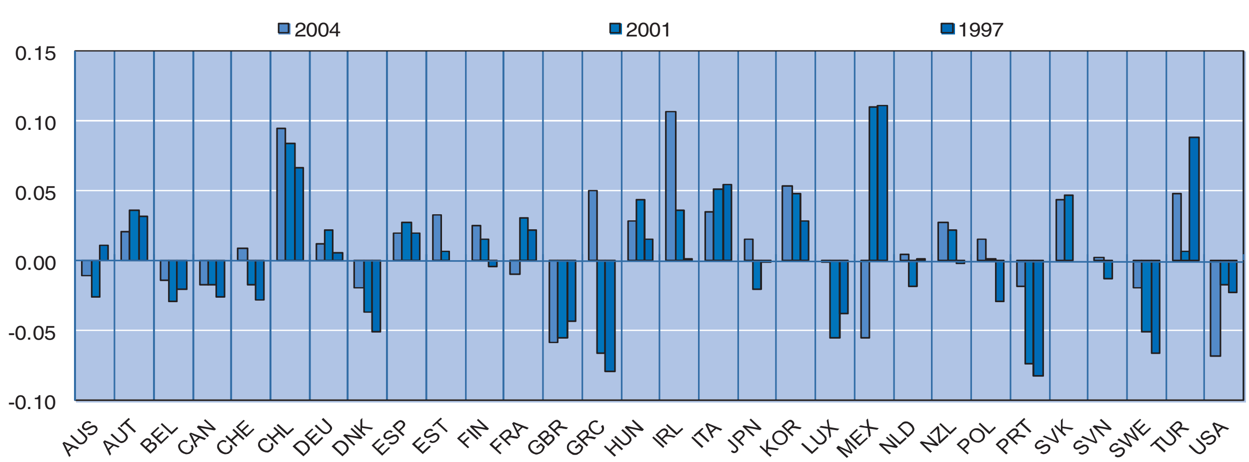
Panel A. Unskilled labour



Panel B. Skilled labour



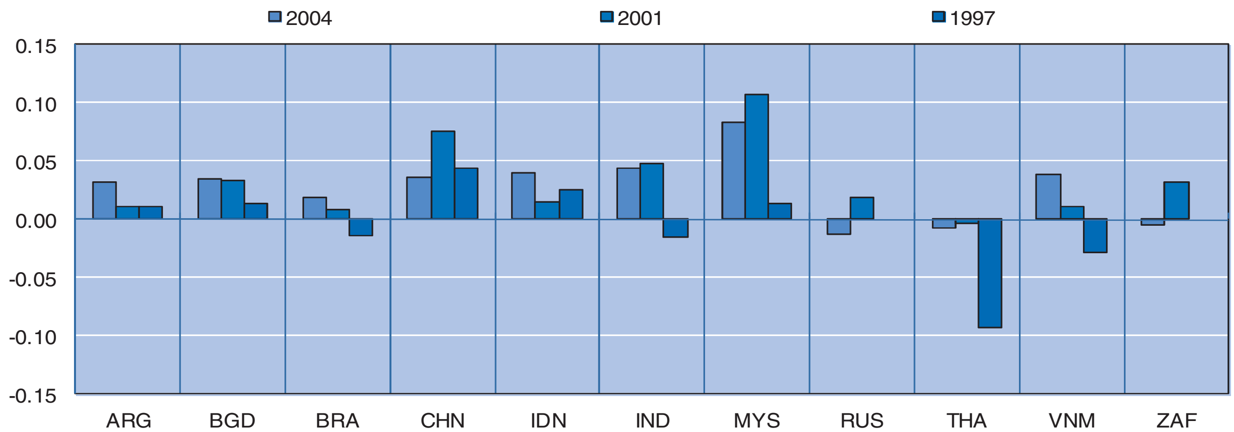
Panel C. Capital



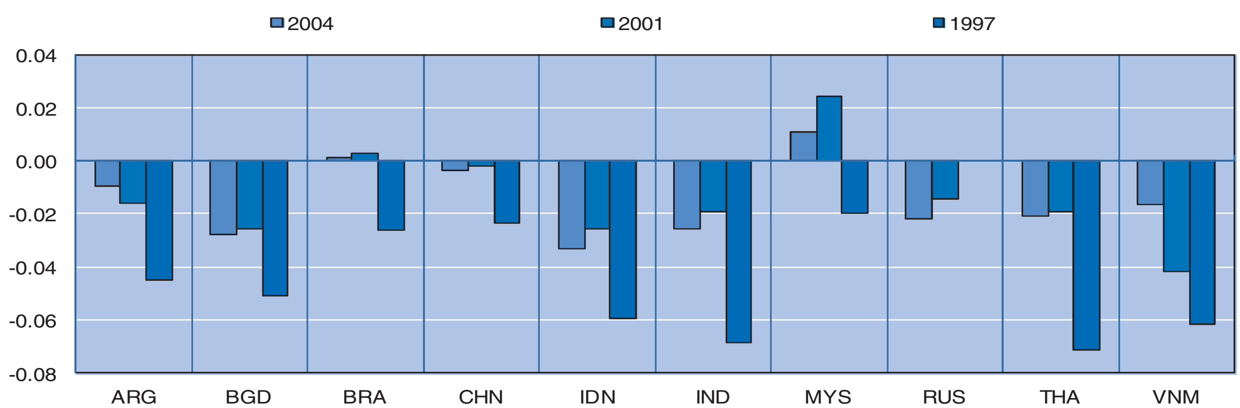
Source: Authors' calculations based on GTAP database versions 5, 6 and 7.1.

Figure 5.8. Country level measures of factor content, selected emerging economies

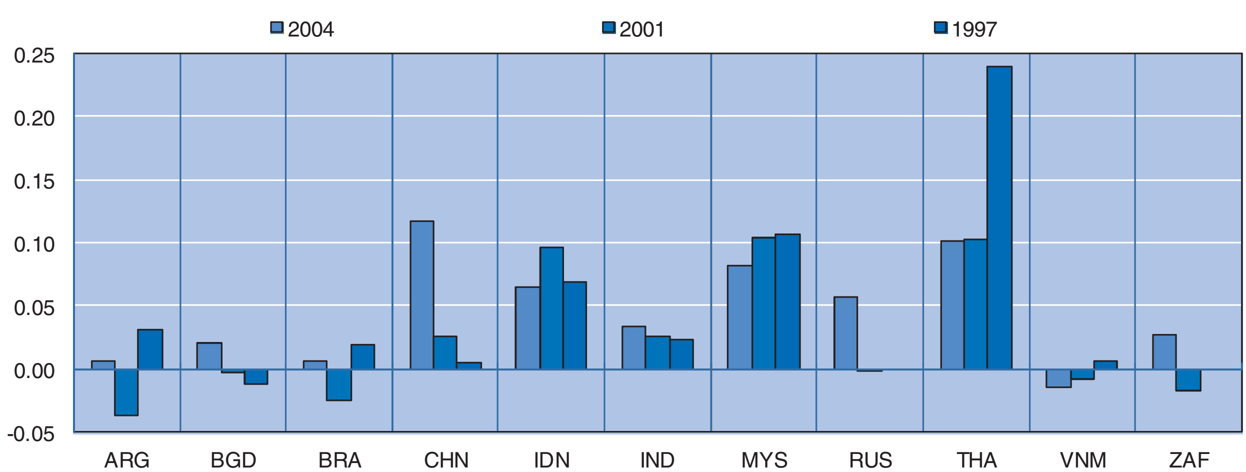
Panel A. Unskilled labour



Panel B. Skilled labour



Panel C. Capital



Source: Authors' calculations based on GTAP database versions 5, 6 and 7.1.

The United States and the United Kingdom are shown to have a negative factor content of trade in capital in each time period examined. This could be due to the "de-industrialisation" of these economies as identified in Chapter 2. The increasing use of resources in the production of services is something that was observed throughout the OECD but especially so in countries such as the United Kingdom and the United States. As further noted in Chapter 2, the share of manufactured exports from the top OECD exporters has been declining over the period 1990-2007.

The three panels in Figure 5.8 look at the same measures for the SEMs. As expected, almost all show a comparative advantage in unskilled labour judging by the factor content of their trade. Some countries, Thailand, Russia and South Africa, show a negative factor content of trade in more recent years, but for South Africa and Russia, this is not a consistent pattern and for Thailand, it is decidedly smaller in recent years. Neither South Africa nor Thailand (information was not available for Russia) have large stocks of unskilled labour with respect to other SEMs (Figure 5.4). Again, as expected, all show a negative balance in skilled labour with the exception of Brazil and Malaysia who both show a positive factor content of trade in this resource in more recent years (2001 and 2004). Interestingly, relative stocks of skilled labour with respect to other SEMs were no higher in these two economies (Figure 5.3) and skilled labour actually ranked fifth in Malaysia's relative factor usage (Table 5.3).

Another interesting observation can be seen in the patterns revealed when looking at capital. All of the SEMs show at least one period with positive factor content for capital. This implies the trade balance in goods using capital is positive and thus these countries have a comparative advantage in this resource. A possible explanation for this pattern is the growing industrial production base of these economies, especially those in Southeast Asia. As observed in Chapter 2, OECD countries are moving toward services and away from traditional 'capital intensive' manufacturing and the slack is being picked up by SEMs. As these countries increase their inflow of FDI and expand their own higher value-added manufacturing processes, the capital content of their trade should necessarily increase. We saw this by the increased rank of capital usage in some of these economies, China especially, implying growing participation of relatively capital intensive goods in their trade.

These outcomes are consistent with the growth in capital stocks in SEMs and a slower investment rate among OECD countries observed above (Figure 5.1). Further, we see the majority of OECD countries which have an increase ranking in capital factor usage are emerging OECD economies like Poland, Mexico and Estonia while only a few SEMs show an increased ranking of capital (China, Thailand and South Africa). However, the increase in relative ranking for China is small, indicating their factor usage is still dominated by other factors, i.e. labour.

When we observe, however, the relative contribution of labour and capital as measured in countries' k/l ratios, we see that capital still dominates among OECD countries. What this implies is that while the production base is shifting, it is shifting slowly. OECD countries still employ a relatively large share of capital reflective of their large capital stocks while SEMs employ larger shares of labour, reflective of their stocks. However, among those sectors seeing the most growth in each region (i.e. services in OECD and manufacturing in SEMs) we see the potential reversal of these resource uses. Overall, the base is dominated by capital in the OECD with changes in labour, while the base is dominated by labour in SEMs and capital is driving the change. This may also imply something about the nature of traded versus non-traded goods. Overall, according to resource rankings, the relative use of labour by OECD countries has remained fairly stable while capital has increased. However, the factor content of resources implies these rankings will change to reflect a declining use of capital among traded goods, and a possible reflection of the shift from manufacturing to services.

What role has intermediate inputs played in measuring factor content of trade?

We can further examine the trends in factor content derived from the traditional HOV specification by comparing the outcomes of an equation which accounts for a country's use of resources embodied in its intermediate inputs with one that does not. This analysis is discussed below. While we developed results at the general country level, we report here those outcomes pertaining to individual sector outcomes.[21]

Including a correctly specified measure of traded intermediates is crucial to a more accurate measurement of factor content. In order to better understand the relative importance of intermediate trade we examine the factor content of trade with and without imported intermediate inputs for China and the United States.[22]

China

We examine the trends in factor content across sectors for three factors of production: skilled labour, unskilled labour and capital. Given that most imported intermediate shares are in the manufacturing sector, we begin our analysis in this area. In addition, because we are comparing with the United States and the changing nature of the two economies stresses the role of services, we include this sector as well.

Figure 5.9 shows the factor content of Chinese trade for skilled labour in three time periods: 1997, 2001 and 2004. The bars represent the factor content of trade as defined by equation (4) without explicitly accounting for intermediate inputs and the dots are defined with intermediate inputs. While measures without show a consistently negative balance across both sectors and time periods, there are significant difference when accounting for intermediates.

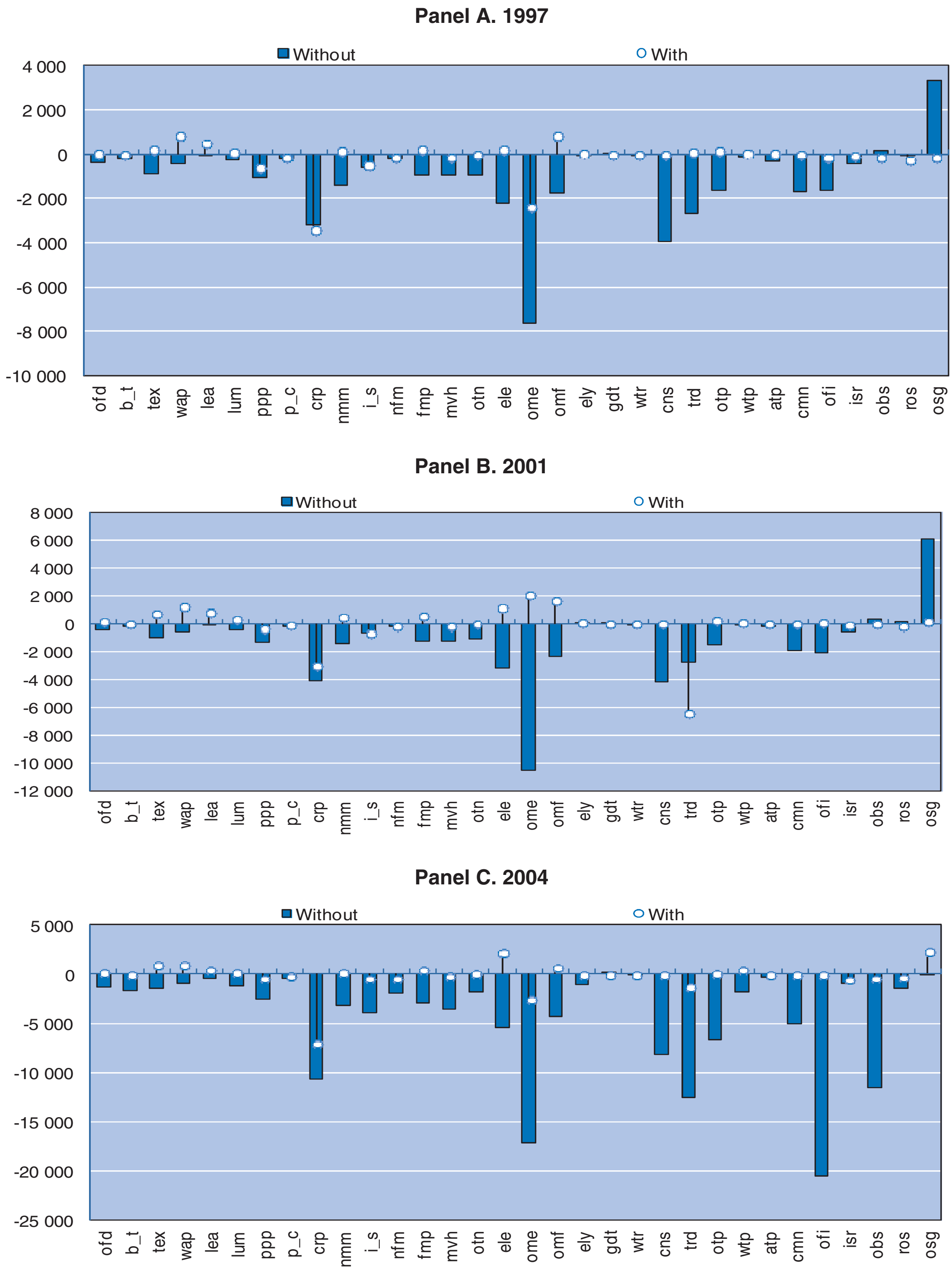
When examining skilled labour, accounting for intermediate inputs in the calculation of factor content reduces the observed deficit, or creates a small surplus, in almost every sector. Notable exceptions are the chemical and rubber sector (crp) and the trade (retail and wholesale, trd) sector in 2001. Thus, for example, it would appear the inputs which China accesses from the rest of the world are more skill intensive in the production of electronics and other manufacturing goods. Across the sectors of textiles (tex), wearing apparel (wap) and leather (lea), the same phenomenon is observed, although to a lesser extent. An outlier is the other services sector consisting of public administration and government services (osg). Here, especially in 1997 and 2001, we see a large surplus reduced to a small deficit in 1997 and balanced trade in 2001 when accounting for the factor content of intermediate inputs. This would imply that China was importing intermediate inputs that are non-highly skill intensive, or at least less skill intensive than non-traded intermediate inputs. By 2004, this trend had reversed itself and including intermediate imports leads to a slightly larger surplus, implying that more skilled labour was now being sourced internationally.

Turning to unskilled labour, shown in Figure 5.10, the pattern of comparative advantage appears to be changing regardless of intermediate inputs (although these inputs impact the results as well). In 1997 and 2001, we observe surpluses in sectors using unskilled labour (before adjusting for intermediate inputs). These include construction (cns), chemicals and rubber, non-metallic minerals (nmm, such as cement, lime and concrete), trade and other business services (obs). By 2004 none of the sectors show a surplus in unskilled labour. This is consistent with the decline in the relative abundance ranking for unskilled labour in China between these two time periods. However, once we account for the factors embodied in intermediate inputs, we observe a number of strong surplus sectors. These include electronics (ele), other manufacturing (omf), textiles, wearing apparel, leather and lumber (lum). Again, this could be an indication of China's own increasing use of production outsourcing, especially in the textiles and electronics sectors.

Capital shows a different story to that of labour (Figure 5.11). In most of the sectors, in all three time periods, China has a small surplus in capital, and we see this trend strengthening in 2004. However, as distinct from labour, including intermediates creates a smaller surplus and even a deficit in many sectors including paper products (ppp), petroleum and coke (p_c), chemical and rubber, iron and steel (i_s), motor vehicles (mvh), other machinery and equipment (ome), and trade. By 2004 many services sectors see shrinking surpluses when intermediate inputs are accounted for, including finance and banking (ofi) and other business services.

As stated above, this implies that most imported intermediate inputs are more capital intensive than other inputs while imported intermediate inputs into chemicals and machinery and equipment, for example, are less capital intensive in 2004. While we do not have detailed source information for intermediate inputs to China, looking at total imports provides some explanation. Japan remains a major source of imports across four of the five sectors in 2004. Taiwan and Korea also contribute significantly to imports of chemicals and rubber and other machinery and equipment while Hong Kong is by far the largest supplier of imports in the trade sector, all sectors with implied higher capital input in imported than domestic intermediates. However, among those sectors which showed lower capital intensity in imports – electronics and other manufacturing – Malaysia, India and Thailand were also significant sources of imports.

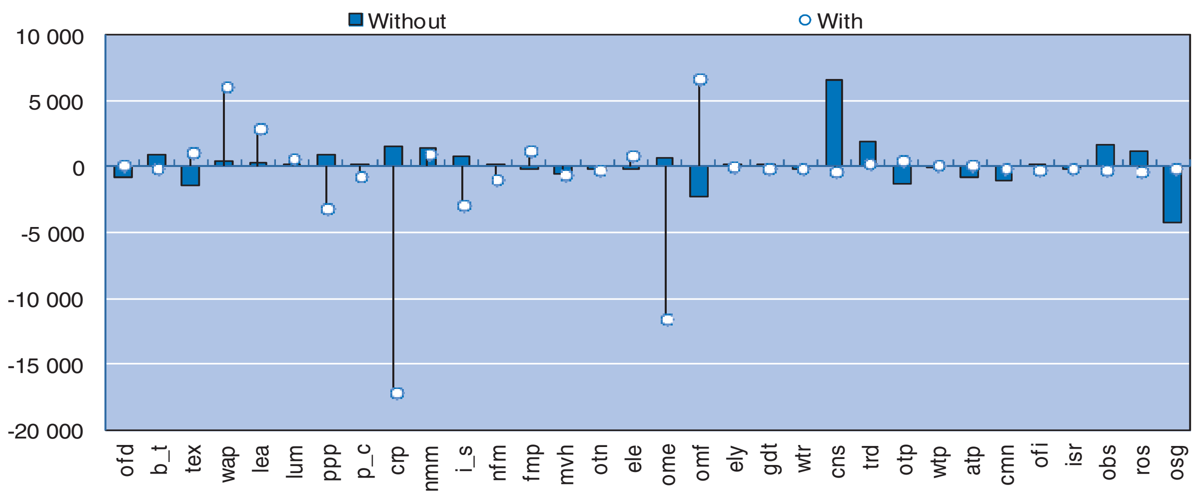
Figure 5.9. China skilled labour



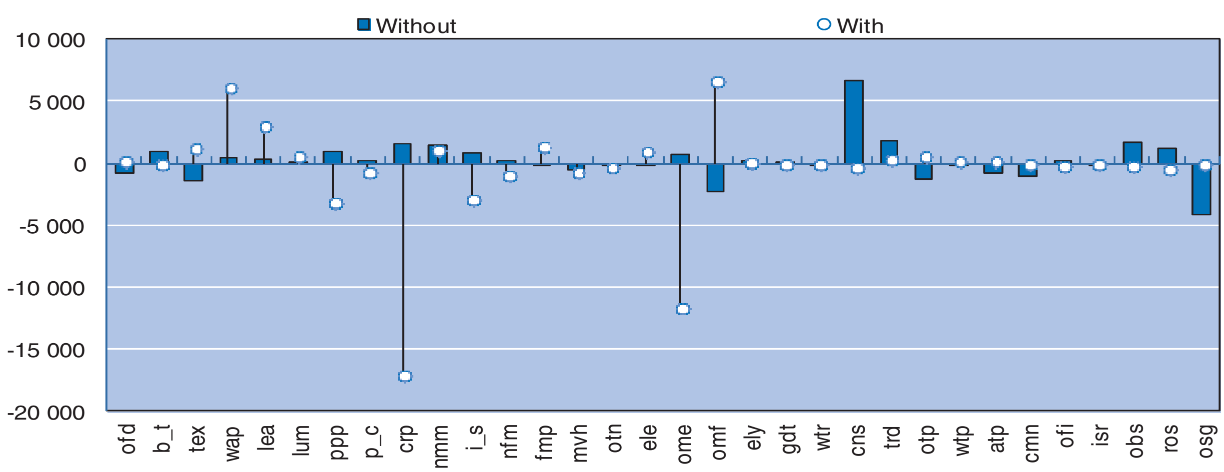
Source: Authors' calculations based on GTAP database versions 5, 6 and 7.1.

Figure 5.10. China unskilled labour

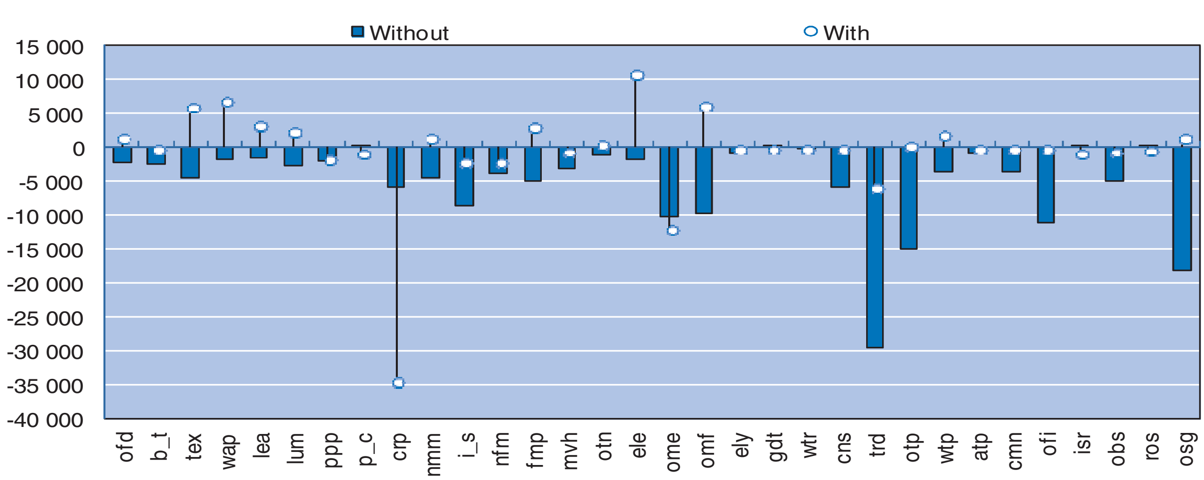
Panel A. 1997



Panel B. 2001



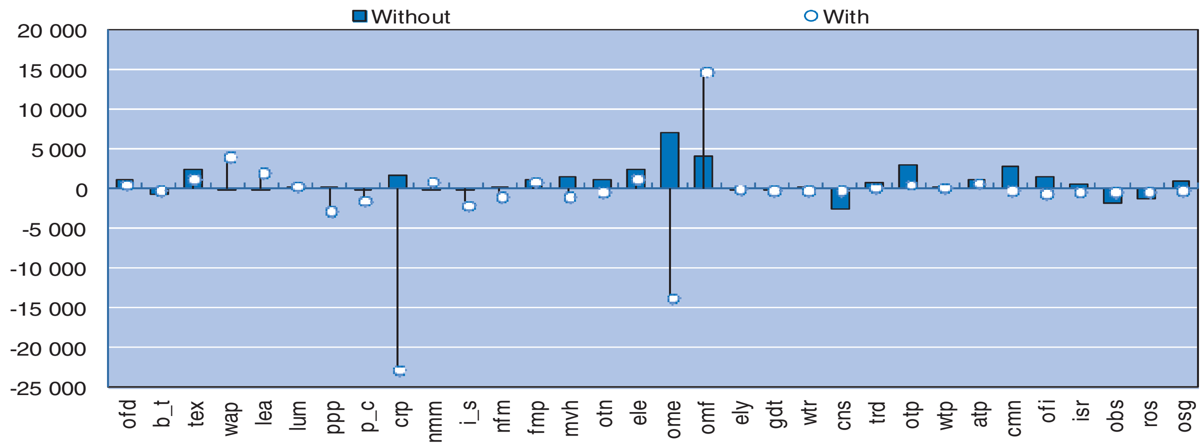
Panel C. 2004



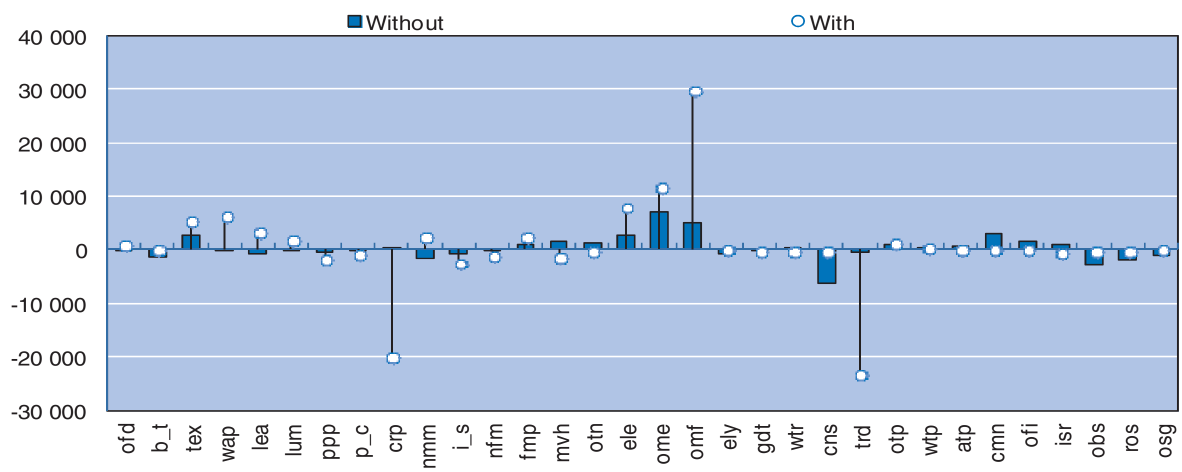
Source: Authors' calculations based on GTAP database versions 5, 6 and 7.1.

Figure 5.11. China capital

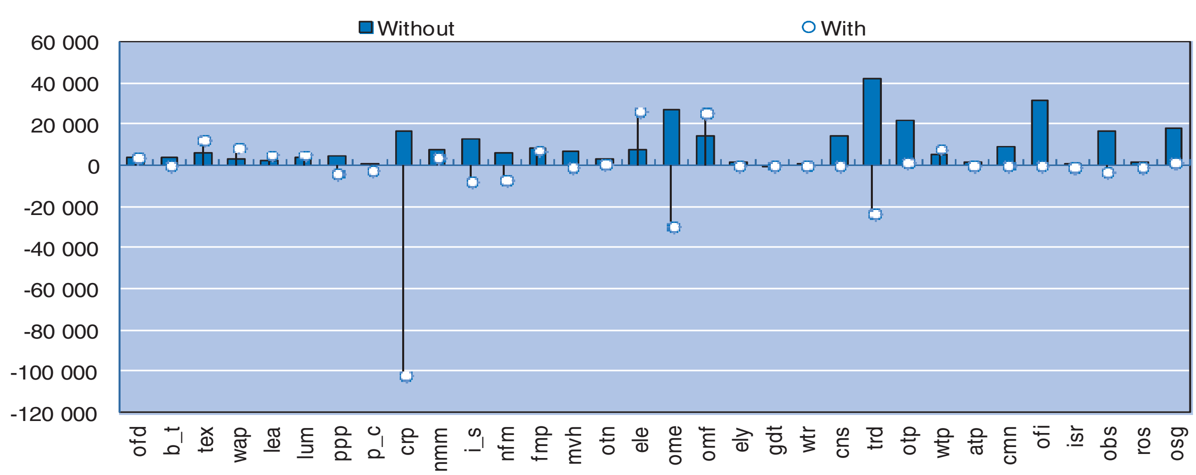
Panel A. 1997



Panel B. 2001



Panel C. 2004



Source: Authors' calculations based on GTAP database versions 5, 6 and 7.1.

The United States

Figure 5.12 shows the same three sets of graphs for the United States, that is, the evolution of surplus/deficit sectors with and without intermediate inputs for skilled labour. Across all three time periods the United States shows a significant surplus in skilled labour in the services sector with other business services showing particular strength in 2004. Other sectors, such as motor vehicles, other machinery and equipment, chemicals and rubber, construction and trade had shown relatively strong surpluses with smaller values in 2004.

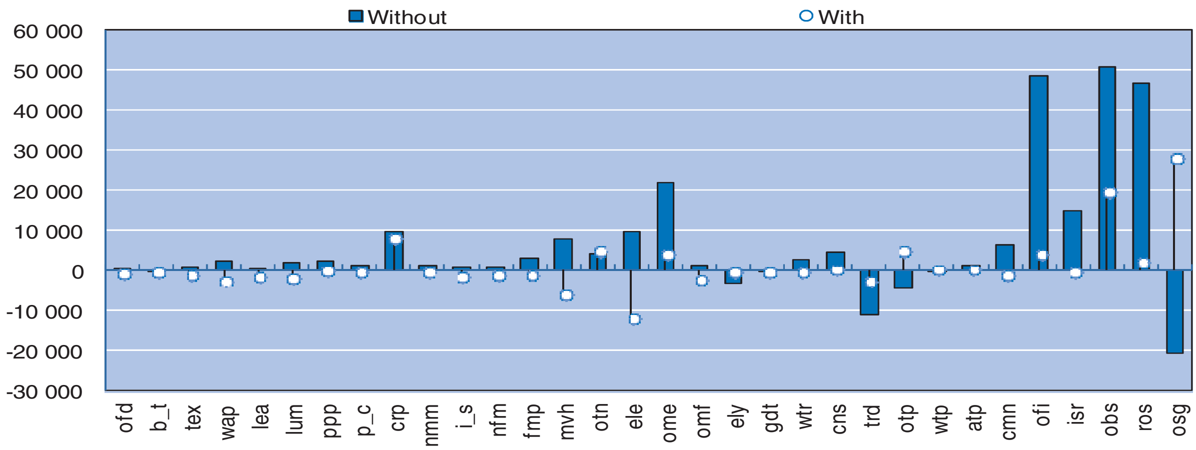
Intermediate inputs make less of a difference in the overall results of the US data over each successive period. Indeed, by 2004 the only sectors outside services that experience a relatively large shift is other machinery and equipment and, to a lesser extent, chemicals and rubber. These small changes are in contrast to China who shows large changes in each time period. While this does not indicate the United States has fewer imported intermediate inputs than China (indeed in many cases the US imports more), rather that the resource profile in the inputs are more similar to those sourced from within the United States.

Much the same pattern holds for unskilled labour in that there are small differences with and without intermediate inputs in sectors outside services (Figure 5.13). Here, however, many of the sectors go from large surpluses to balanced trade, implying that the United States imports unskilled-intensive intermediates. Sectors that maintain their surplus, albeit at a lower level include other transport equipment (otn), banking and business and government services sectors. Again, this implies that the United States trade in goods using unskilled labour is generally in balance with the exception of a few sectors, and trade in intermediate inputs has only a limited role to play in this story.

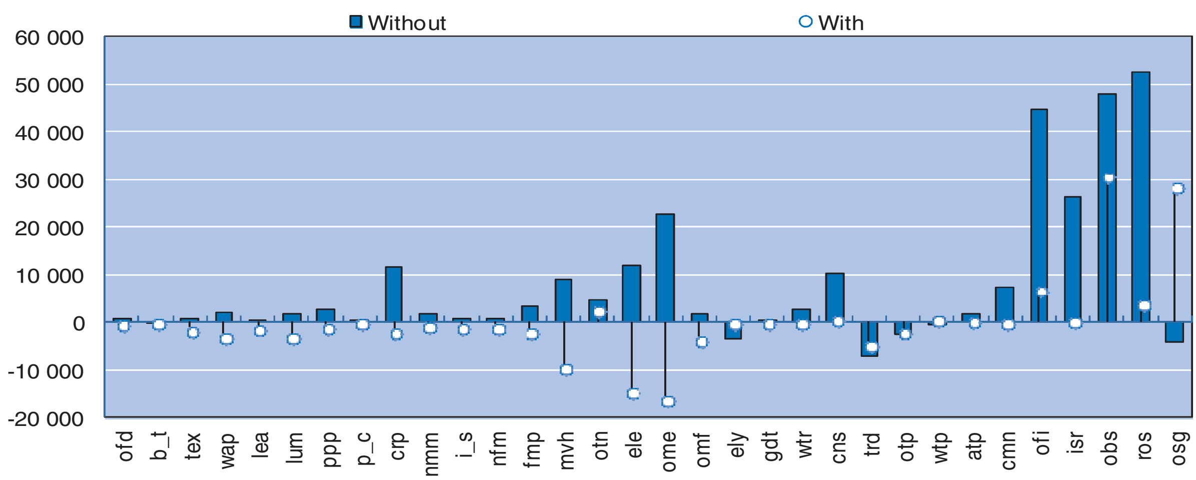
As noted above, the role of capital in US trade is not as large as one would have expected *a priori* (Figure 5.14). Indeed, across the manufacturing sectors there are no significant surplus sectors in any of the three time periods examined with most of these sectors remaining more or less in balance. However, there are significant deficits across many of the services sectors. In 2004, the deficit in other business services sector was particularly large. Indeed, all of the service sectors (with the exception of the transport sectors) show deficits in each period. Thus, it would appear these sectors are driving the deficit in capital observed for the United States in Figure 5.7.

Figure 5.12. United States skilled labour

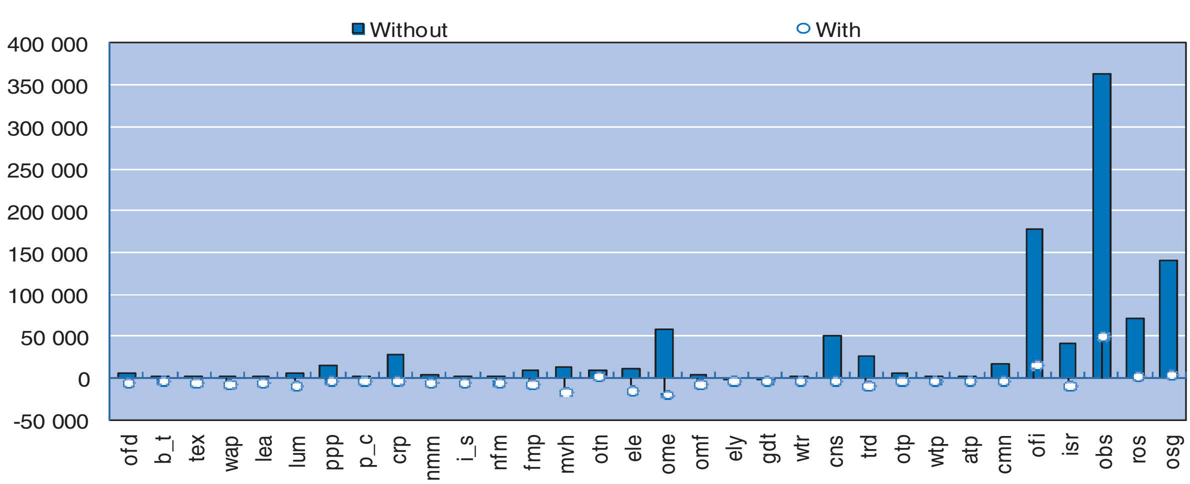
Panel A. 1997



Panel B. 2001



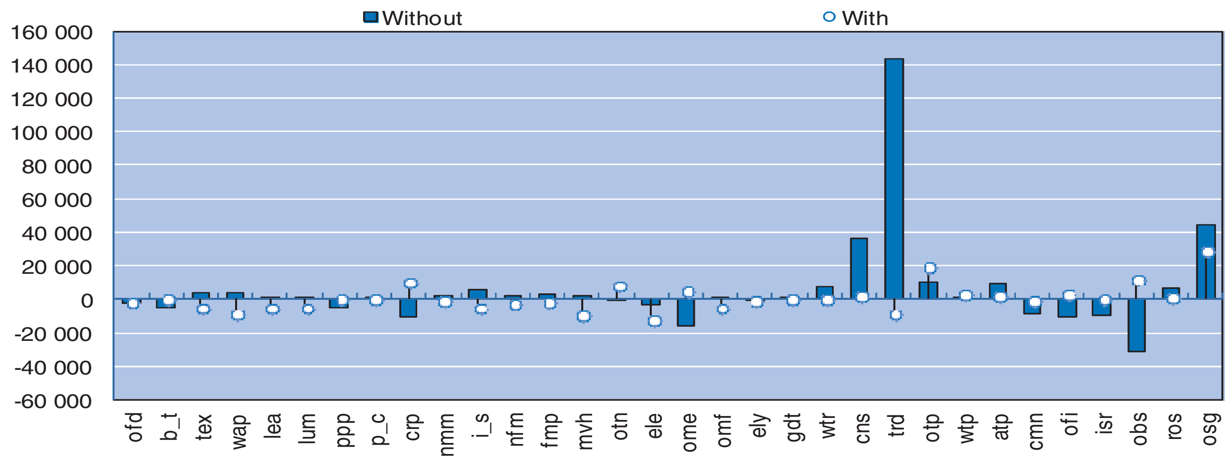
Panel C. 2004



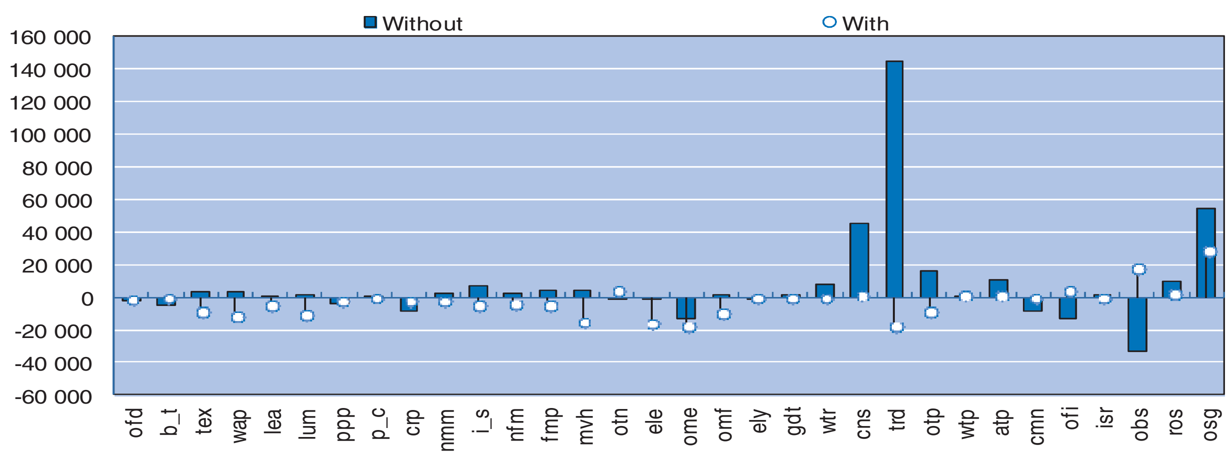
Source: Authors' calculations based on GTAP database versions 5, 6 and 7.1.

Figure 5.13. United States unskilled labour

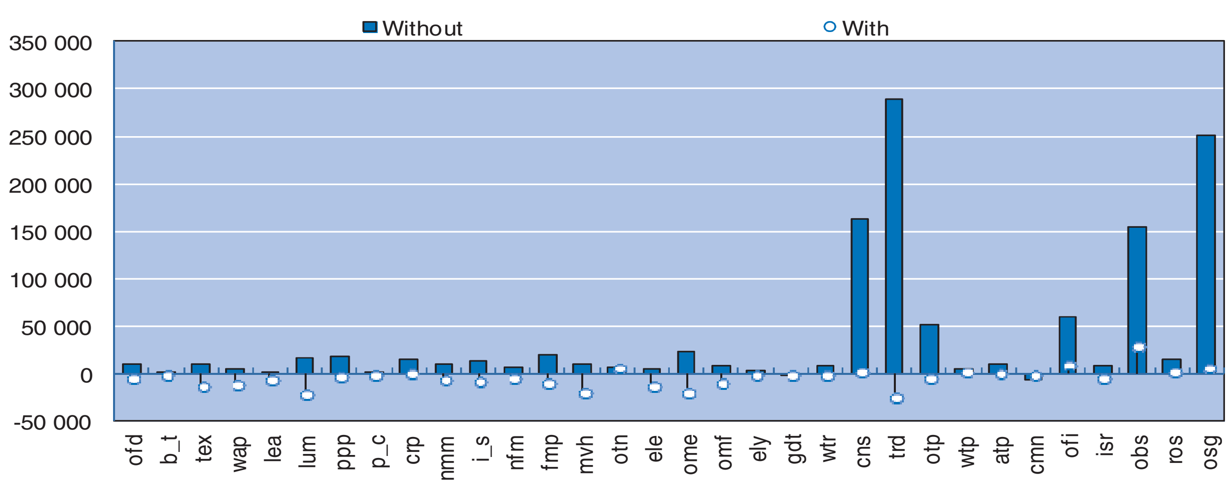
Panel A. 1997



Panel B. 2001



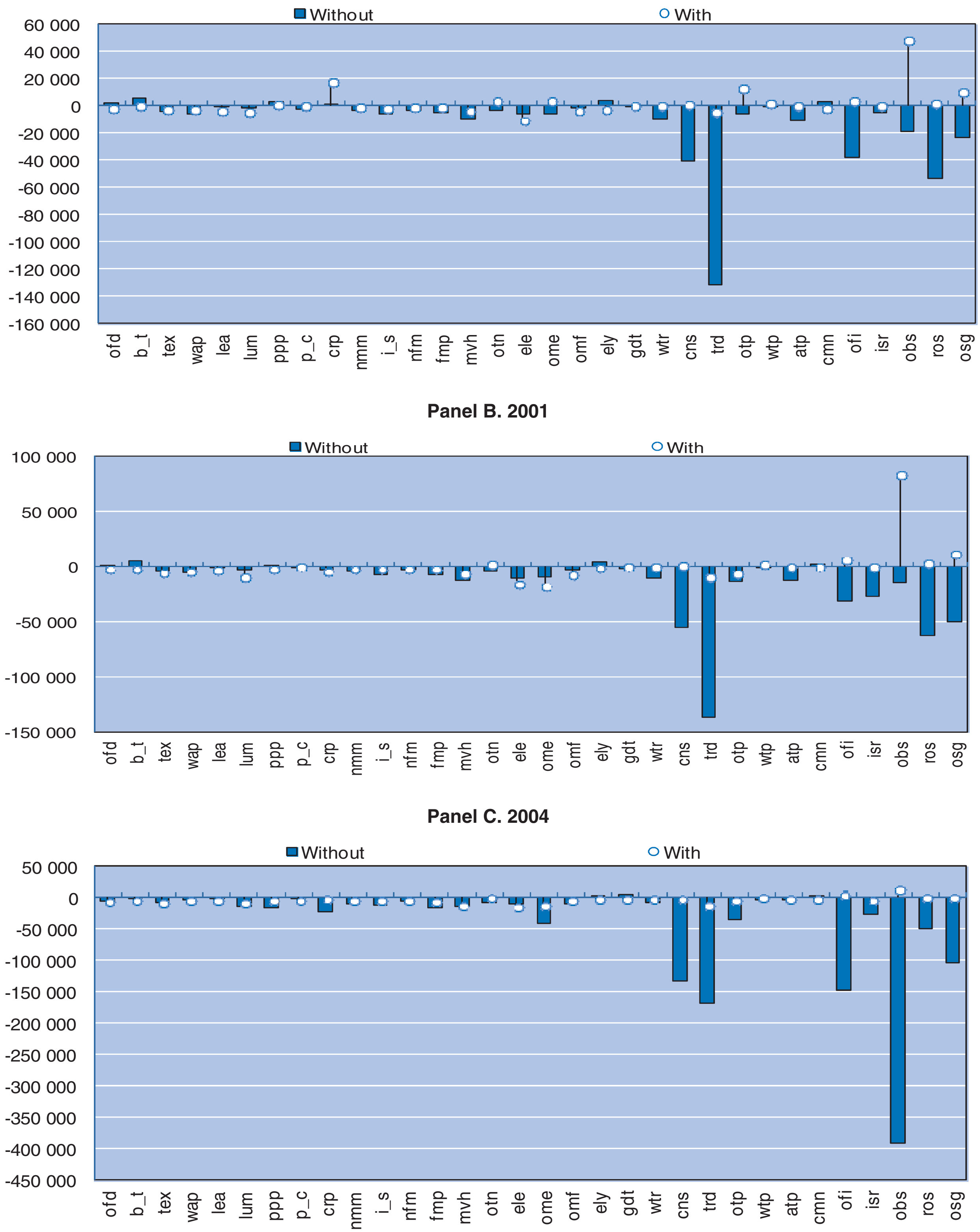
Panel C. 2004



Source: Authors' calculations based on GTAP database versions 5, 6 and 7.1.

Figure 5.14. United States capital

Panel A. 1997



Source: Authors' calculations based on GTAP database versions 5, 6 and 7.1.

When adjusting for intermediate inputs, the deficits in the services sector change considerably. Most of the deficit sectors move to a balanced trade or even surplus as in the case of other business and government services. One of the issues with the measurement of capital is that we are unable to determine what part of the imported intermediate goods are made with the exporting country's capital from that which may be produced with US capital employed overseas. Thus, while it appears the United States is a net importer of capital in these sectors, it may be that a large part of the capital is owned by US companies. Grossman and Rossi-Hansberg (2009) show that trade between US companies and their foreign subsidiaries accounted for 47% of US imports in 2005. Further, they show that US imports in "Business, Professional and Technical Services" (which overlaps with our other business services) grew in real terms by more than 66% between 1997 and 2004.

From this analysis we can see what has been a growing acknowledgement in trade circles: intermediate trade matters. Further, we see that it affects factors differently. Thus if policy is to be effective, it must rely on analysis which includes intermediate trade and the embodied factor services in this trade, and includes it in a meaningful way, i.e. measured in terms of value added. How this information can be used in the formation of trade policy will be discussed in more detail Chapter 6.

Conclusions

OECD economies as a whole continue to hold the lion's share of capital and skilled labour endowment stocks while SEMs hold more unskilled labour. Overall, measures of factor content of trade reflect these holdings. However, while OECD countries have been shown to be accumulating capital stocks at a rapid rate, over 4% *per annum* for the past 15 years, SEMs have been doing so at an even faster rate, over 11% over the same time period. The same observation can be made for skilled labour; OECD stocks growing at over 3% while SEMs are growing at an annual rate of almost 5%.

Capital/labour (k/l) ratios show that OECD economies remain relatively capital intensive, and this is confirmed in the relative rankings of the intensity of this resource use in traded goods. Capital consistently ranks high, as does skilled labour. For SEMs, we see smaller k/l ratios and these factors rank lower in their relative usage; unskilled labour ranks high, but natural resources and land figure prominently in the relative intensity of factor usage for SEMs as well. There are broad exceptions (such as Australia for natural resources and Brazil for capital) but overall these results hold.

If, however, we look a little deeper at movements in the rankings and relate them to the observed difference in factor accumulation across the country sample, we see increasing use of unskilled labour in OECD countries and capital increasing its intensity among SEMs.

These changing dynamics are reflected in the total factor content of trade for capital, skilled labour and unskilled labour. However, the analysis did yield some unexpected results. Among the OECD economies, the two largest capital stock holders – Japan and the United States – show deficits in the trade of capital embodied goods. More in line with expectations, newly emerging OECD economies such as Hungary, Chile and Poland, all show strong surpluses. We see an increase in the use of unskilled labour embodied in US and Japanese trade, but also in Korea and Australia. SEMs show a strong surplus in unskilled labour trade across the board. Finally, skilled labour stocks are strongest in the

United States and Japan and both show a sizable surplus in the factor content of skill embodied trade while only Malaysia and Brazil among the SEMs show a surplus here.

The picture emerging among the OECD economies is thus more varied and nuanced than that among the SEMs. Part of the explanation for the OECD results could be the manner in which we think and account for factors. That is, whether the traditional method of measuring actual units of capital and labour, located with the geographic boundaries of a country, is still appropriate. Rather, we should be looking at more refined measures of individual tasks and factors roles in intermediate inputs, which are not necessarily defined by geographic boundaries. The large literature on production fragmentation and offshoring attest to this trend. Trade, even factor content, can no longer be thought of as a function of the endowments located solely within a country's borders, but rather can be seen as a function of trade-in-goods and trade-in-tasks where the level and direction of this trade are a function of the changes in the costs of moving goods and particular tasks and ideas, rather than "jobs."

Baldwin and Robert-Nicoud (2010) present a model which attempts to integrate these new patterns of firm behaviour into traditional trade theory like HOV. They argue this movement of tasks creates "shadow migration" and changes the way factors are characterised in standard trade theory. This, they argue, explains why standard trade theory presents so many "unexpected" results.

This observation can be inferred from the analysis of trends in factor content with and without fully accounting for imported intermediate trade flows. We observe shifting patterns in comparative advantage depending on whether we account for worldwide use of resources, regardless of location. In the United States, we see changes mainly across the services sector while China experiences large differentials in the outcome of their manufacturing sector – both of these dynamic and growing sectors in the respective economies.

As the driving forces behind trade patterns change, so must the approach to measuring these patterns. We have shown that intermediate goods play an important role in the analysis driving policy advice. In addition, inferred here is the importance of foreign direct investment and the role domestic capital, employed overseas, can make to notions of trade deficits or surpluses. Thus, policy advice based on simplistic measures of trade can be misleading.

Given that resource stocks are still a major driver of trade patterns, policies that develop and enhance these stocks will help countries shape their future comparative advantage.

We have shown that factor content is an important determinant of comparative advantage and that comparative advantage, in turn, drives trade patterns. What is important for policy makers is the fact that this directional flow – endowments to comparative advantage to trade – does not work in the reverse order. Targeting industries and "picking winners" is inefficient in the long run, because it is inconsistent with this basic causal flow. Therefore, trying to impact endowment sectors – such as employment – through trade policy is counter-productive. That is not to say that a country cannot have an influence on its comparative advantage, rather this is best accomplished by developing factors more broadly. A major policy implication of this work is that the best approach to influencing trade outcomes is to invest in resource market enhancement, such as education and training for labour and transparency and availability for capital.

Notes

1. Susan F. Stone, Senior Trade Policy Analyst, OECD Trade and Agriculture Directorate, Ricardo H. Cavazos Cepeda, Director General, Estudios Económicas Comisión Federal para la Protección Contra Riesgos Sanitarios Mexico and Anna Jankowska, Junior Policy Analyst, Development Centre, OECD. Material presented in this chapter is based on the work declassified by the OECD Working Party of the Trade Committee as *OECD Trade Policy Working Paper* No. 109 (Stone *et al.*, 2011).

2. The model was originally formulated by Heckscher (1919) and further developed by Ohlin (1933) and formalised by Samuelson through a series of papers between 1948 and 1953. The model is often also referred to as the Heckscher-Ohlin-Samuelson model.

3. For an extensive review of empirical studies during this period see Leamer and Levinsohn (1995).

4. This is a share of the total capital stocks for the 38 countries for which data is available. Data was not available for Poland, Turkey, the Slovak Republic, and the Czech Republic. The net capital stocks are calculated from real GFCF series from the World Bank WDI. See data annex for calculation details.

5. The data for workforce by education level and gender comes from the IIASA and Vienna Institute for Demography data sets for 1970-1995 and 2000-2050, further details on about these datasets can be found in the data annex.

6. Skilled workers are those who have completed tertiary education.

7. Labour ratios are taken from the same source as labour stocks reported above. That is, the working age population (15+) from the IIASA/VID Human Capital and Economic Growth Program. This measure includes all available human capital, and does not distinguish economically active population from those who do not participate. The same ratios were constructed using figures for economically active labour force from the World Bank World Development Indicators, and the resulting ratios demonstrated similar trends.

8. For ease of discussion, we show only selected OECD countries. For a complete table of ratios can be found in the data annex.

9. Real GDP measures and total labour force were taken from the World Bank (2010), *World Development Indicators*.

10. There is a vast literature on the relationship between capital and labour productivity. See, for instance, Romer (1990).

11. See Trefler and Zhu (2010) for the technical proof.

12. Again, Trefler and Zhu (2010) report the details on the derivation of θ.

13. See the Technical Appendix for a more detailed explanation of our approach to measuring factor content.

14. For complete documentation of the GTAP database see *www.gtap.agecon.purdue.edu/databases/default.asp*. Summary details of the data used in our analysis, including on individual input-output tables, can be found in the Annex 5.A.

15. While most variables under consideration change consistently with each database version, there are nonetheless some measures which do not. Therefore, caution should be used when comparing results across time as changes in the underlying input-output tables are not consistent. See Annex Table 5.A2 for details.

16. Completed documentation of the methods used to split total labour payments into skilled and unskilled can be found in Liu *et al*. (1998a, b).

17. We report rankings using adjusted income shares. The rankings using consumption shares were qualitatively similar and are available upon request.

18. While we are able to look at a greater level of factor disaggregation than previous studies, our measures are still quite broad. It is to be expected that if we could conduct this analysis at an even more refined level of inputs (e.g. different types of skilled labour) we may see different patterns emerging.

19. See endnote 14.

20. The values at the economy-wide level were scaled by relative income measures to ease comparisons.

21. Table Annex 5.A2 provides a list of sectors covered.

22. While similar comparisons are available for all covered countries, as two of the largest trading nations, we focus our discussion on these two countries.

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Annex 5.A

Data details

Stocks for both capital and labour are expressed in units. The capital stocks were calculated with the perpetual inventory method using real gross fixed capital formation flows from the World Bank World Development Indicators. For the base stock in 1980, an average of Gross Fixed Capital Formation (GFCF) flows was calculated from 1978 to 1982 to limit year specific anomalies and multiplied by two. The depreciation rate used was 7%. The stocks were adjusted with the price of investment from the Penn World Tables to convert the PPP values into units of capital. Data for stocks were unavailable for Poland, Slovak Republic, Turkey, Slovenia, Singapore, and Israel.

Labour stocks were taken from the IIASA and Vienna Institute for Demography data sets. Labour stocks are defined as total population over the age of fifteen, providing information about the total human capital available, but not differentiating between economically active and those that are unable or choose not to work. These data report populations by age, sex and level of educational attainment for 120 countries for 1970-2000 using demographic back projection methods. Skilled labour includes the population with completed tertiary education. This data set takes into account fertility, mortality, and migration rates for improving the accuracy of population projections by education level. The data and methodology paper can be accessed at: *www.iiasa.ac.at/Research/POP/edu07/index.html?sb=12*.

Given actual observations for 2005 are unavailable, the data for 2005 was taken from the Education Forward Projections dataset for 2000-2050. The data was based on the Global Education Trend Scenario series which assumes that a country's educational expansion will converge on an expansion trajectory based on the historical global trend. Identification of the global trend is based on a data driven-judgmental analysis.

For the labour productivity calculations of output per worker, we used World Bank World Development Indicators of total labour force and GDP in constant USD 2000. Ideally, a measure of GDP per hour worked would have been useful, but no complete cross country data on this was available at this time.

Data was also taken from the Global Trade Analysis Project (GTAP). This publicly available, completely documented (Dimaranan and McDougall (2002) and Badri and Walmsley (2008)) database provides input-output tables for between 45 and 85 countries (depending on the database version), 57 sectors and five factors of production. It consists of independently complied country-specific input-output tables (thus allowing us to recover country-specific technology matrices) which are reconciled to bilateral trade data and other statistics. The data have been through seven public releases and have been extensively tested by members of the GTAP consortium and other researchers.

In order to observe the factor content in different time periods, we use three of the GTAP databases to derive the necessary components of this part of our analysis. These databases are version 5, corresponding to a base year of 1997; version 6 corresponding to a base year of 2001 and version 7, corresponding to a base year of 2004. To cover as many countries and sectors in a consistent manner, GTAP measurements are made in value terms (USD). This allows the consistent basis from which to compare outcomes across countries. While we do acknowledge the well known shortcomings of measuring economic variables in USD (as well as the shortcomings of other measures such a PPP), we believe the value in obtaining an internally consistent database outweighs any potential bias introduced in our figures.

Table 5.A1. K/L ratios

Units of capital per worker

	1990	1995	2000	2005
Argentina	25 027.71	24 963.70	29 031.27	50 603.00
Australia	47 984.56	61 242.59	88 428.75	86 917.43
Austria	57 194.21	58 169.80	93 797.58	85 366.51
Belgium	50 858.29	54 773.70	87 223.29	82 072.87
Brazil	14 132.71	13 384.56	17 211.65	15 265.45
Canada	50 295.96	68 773.98	80 592.82	86 509.98
Chile	11 684.57	16 876.81	28 857.29	39 020.01
China	2 952.20	5 395.86	8 058.30	12 227.42
Denmark	39 962.64	46 209.82	79 870.82	79 840.02
Egypt	76 815.51	225 185.86	241 848.62	480 194.61
Finland	43 975.70	57 751.91	83 365.83	80 671.47
France	45 368.80	50 476.94	77 715.92	70 750.18
Germany	48 851.79	49 130.41	81 723.22	78 734.96
Greece	37 986.96	37 348.82	51 380.99	52 461.02
Hong Kong, China	75 947.57	72 881.85	89 190.55	145 027.86
Hungary	20 165.43	20 435.05	30 742.68	25 484.41
India	1 850.13	2 881.34	3 984.30	4 886.38
Indonesia	4 281.83	5 651.73	6 874.12	6 363.64
Ireland	61 722.61	64 024.78	81 884.87	69 686.52
Italy	44 856.61	63 760.25	83 875.00	74 241.22
Japan	100 880.79	85 978.13	113 901.52	154 905.53
Korea	33 734.85	47 120.84	74 320.59	84 208.53
Luxembourg	80 649.34	86 609.02	149 730.57	156 249.59
Malaysia	15 195.45	21 906.55	34 021.57	39 200.30
Mexico	29 410.47	31 616.46	27 388.87	29 331.40
Netherlands	44 255.00	47 810.81	81 938.65	74 322.11
New Zealand	31 235.44	31 388.73	51 478.27	44 276.85
Norway	76 736.90	84 318.14	119 675.21	103 074.56
Philippines	8 861.40	6 830.86	9 543.59	11 249.90
Portugal	36 187.41	40 573.54	62 153.61	56 041.40
South Africa	8 494.66	8 133.53	11 114.74	9 628.17
Spain	37 803.89	49 149.74	70 906.96	59 273.93
Sweden	35 430.95	47 968.19	64 550.95	67 691.21
Switzerland	67 252.81	77 852.19	113 644.83	110 233.74
Thailand	14 866.11	21 422.33	28 313.13	27 519.37
United Kingdom	33 708.74	47 202.73	57 644.77	63 919.79
United States	64 482.50	77 559.25	94 770.41	118 937.69

Source: World Development Indicators (WDI) and IIASA/VID.

Annex Table 5.A2. Country and input/output table coverage

		GTAP7.1	GTAP6	GTAP5
Code	World Economy	2004	2001	1997
ARG	Argentina	2000	2000	**
AUS	Australia	1997	1997	1994
AUT	Austria	2000	1983	1983
BEL	Belgium	2000	1995	1995
BGD	Bangladesh	1994	1994	1994
BRA	Brazil	1996	1996	1996
CAN	Canada	2003	1990	1990
CHE	Switzerland	2005	1990	1990
CHL	Chile	2003	1996	**
CHN	China	2007	1997	1997
DEU	Germany	2000	1995	1995
DNK	Denmark	2000	1992	1992
ESP	Spain	2000	1994	1994
EST	Estonia	2000	1997	1997
FIN	Finland	2000	1995	1995
FRA	France	2000	1992	1992
GBR	United Kingdom	2000	1990	1990
GRC	Greece	2000	1995	1995
HKG	Hong Kong	1988	1988	1988
HUN	Hungary	2000	1996	1991
IDN	Indonesia	2004	1995	1995
IND	India	2000	1994	1994
IRL	Ireland	2000	1990	1990
ITA	Italy	2000	1992	1992
JPN	Japan	2000	2000	1995
KOR	Korea	2003	2000	1995
LUX	Luxembourg	2000	1995	1995
MEX	Mexico	2002	2002	**
MYS	Malaysia	1995	1995	1995
NLD	Netherlands	2000	2001	1995
NOR	Norway	2004	2002	1995
NZL	New Zealand	1996	1996	1993
POL	Poland	2000	1997	1997
PRT	Portugal	2000	1993	1993
RUS	Russian Federation	2003	1997	1997
SGP	Singapore	1995	1995	1995
SVK	Slovakia	2000	1997	1997
SVN	Slovenia	2000	1997	1997
SWE	Sweden	2000	1985	1985
THA	Thailand	1995	1995	1995
TUR	Turkey	1998	1995	1995
USA	United States of America	2002	1996	1996
VNM	Vietnam	2003	1996	1996
ZAF	South Africa	2005	1995	1995

** Not explicitly stated. Adjustments are made to ensure that the I-O table matches the external macroeconomic, trade, protection and energy data (GTAP documentation chapter 19). The I-O tables only contain data on the aggregate value of labour. Using other data sources, skilled and unskilled labour were split as well as revisions made to primary factor usage in agriculture and resource-intensive industries (GTAP documentation chapter 18.C and 18.D).

Source: GTAP, *www.gtap.agecon.purdue.edu/databases*, various years.

Annex Table 5.A3. GTAP sector coverage

Code	Description
pdr	Paddy rice: rice, husked and unhusked
wht	Wheat: wheat and meslin
gro	Other grains: maize (corn), barley, rye, oats, other cereals
v_f	Vegetables and Fruit: vegetables, fruit vegetables, fruit and nuts, potatoes, cassava, truffles,
osd	Oil seeds: oil seeds and oleaginous fruit; soy beans, copra
c_b	Cane and beet: sugar cane and sugar beet
pfb	Plant fibres: cotton, flax, hemp, sisal and other raw vegetable materials used in textiles
ocr	Other Crops: live plants; cut flowers and flower buds; flower seeds and fruit seeds; vegetable seeds, beverage and spice crops, unmanufactured tobacco, cereal straw and husks, unprepared, whether or not chopped, ground, pressed or in the form of pellets; swedes, mangolds, fodder roots, hay, lucerne (alfalfa), clover, sainfoin, forage kale, lupines, vetches and similar forage products, whether or not in the form of pellets, plants and parts of plants used primarily in perfumery, in pharmacy, or for insecticidal, fungicidal or similar purposes, sugar beet seed and seeds of forage plants, other raw vegetable materials
ctl	Cattle: cattle, sheep, goats, horses, asses, mules, and hinnies; and semen thereof
oap	Other animal products: swine, poultry and other live animals; eggs, in shell (fresh or cooked), natural honey, snails (fresh or preserved) except sea snails; frog legs, edible products of animal origin n.e.c., hides, skins and fur skins, raw, insect waxes and spermaceti, whether or not refined or coloured
rmk	Raw milk
wol	Wool: wool, silk, and other raw animal materials used in textile
frs	Forestry: forestry, logging and related service activities
fsh	Fishing: hunting, trapping and game propagation including related service activities, fishing, fish farms; service activities incidental to fishing
col	Coal: mining and agglomeration of hard coal, lignite and peat
oil	Oil: extraction of crude petroleum and natural gas (part), service activities incidental to oil and gas extraction excluding surveying (part)
gas	Gas: extraction of crude petroleum and natural gas (part), service activities incidental to oil and gas extraction excluding surveying (part)
omn	Other mining: mining of metal ores, uranium, gems. other mining and quarrying
cmt	Cattle meat: fresh or chilled meat and edible offal of cattle, sheep, goats, horses, asses, mules, and hinnies. Raw fats or grease from any animal or bird.
omt	Other meat: pig meat and offal. preserves and preparations of meat, meat offal or blood, flours, meals and pellets of meat or inedible meat offal; greaves
vol	Vegetable oils: crude and refined oils of soya-bean, maize (corn),olive, sesame, ground-nut, olive, sunflower-seed, safflower, cotton-seed, rape, colza and canola, mustard, coconut palm, palm kernel, castor, tung jojoba, babassu and linseed, perhaps partly or wholly hydrogenated, inter-esterified, re-esterified or elaidinised. Also margarine and similar preparations, animal or vegetable waxes, fats and oils and their fractions, cotton linters, oil-cake and other solid residues resulting from the extraction of vegetable fats or oils; flours and meals of oil seeds or oleaginous fruits, except those of mustard; degras and other residues resulting from the treatment of fatty substances or animal or vegetable waxes.
mil	Milk: dairy products
pcr	Processed rice: rice, semi- or wholly milled
sgr	Sugar

Annex Table 5.A3. GTAP sector coverage *(cont.)*

ofd	Other food: prepared and preserved fish or vegetables, fruit juices and vegetable juices, prepared and preserved fruit and nuts, all cereal flours, groats, meal and pellets of wheat, cereal groats, meal and pellets n.e.c., other cereal grain products (including corn flakes), other vegetable flours and meals, mixes and doughs for the preparation of bakers' wares, starches and starch products; sugars and sugar syrups n.e.c., preparations used in animal feeding, bakery products, cocoa, chocolate and sugar confectionery, macaroni, noodles, couscous and similar farinaceous products, food products n.e.c.
b_t	Beverages and tobacco products
tex	Textiles: textiles and man-made fibres
wap	Wearing Apparel: Clothing, dressing and dyeing of fur
lea	Leather: tanning and dressing of leather; luggage, handbags, saddlery, harness and footwear
lum	Lumber: wood and products of wood and cork, except furniture; articles of straw and plaiting materials
ppp	Paper and paper products: includes publishing, printing and reproduction of recorded media
p_c	Petroleum and coke: coke oven products, refined petroleum products, processing of nuclear fuel
crp	Chemical Rubber Products: basic chemicals, other chemical products, rubber and plastics products
nmm	Non-metallic minerals: cement, plaster, lime, gravel, concrete
i_s	Iron and steel: basic production and casting
nfm	Non-ferrous metals: production and casting of copper, aluminium, zinc, lead, gold, and silver
fmp	Fabricated metal products: Sheet metal products, but not machinery and equipment
mvh	Motor vehicles: cars, lorries, trailers and semi-trailers
otn	Other transport equipment: Manufacture of other transport equipment
ele	Electronic equipment: office, accounting and computing machinery, radio, television and communication equipment and apparatus
ome	Other machinery and equipment: electrical machinery and apparatus n.e.c., medical, precision and optical instruments, watches and clocks
omf	Other manufacturing: includes recycling
ely	Electricity: production, collection and distribution
gdt	Gas distribution: distribution of gaseous fuels through mains; steam and hot water supply
wtr	Water: collection, purification and distribution
cns	Construction: building houses factories offices and roads
trd	Trade: all retail sales; wholesale trade and commission trade; hotels and restaurants; repairs of motor vehicles and personal and household goods; retail sale of automotive fuel
otp	Other transport: road, rail ; pipelines, auxiliary transport activities; travel agencies
wtp	Water transport
atp	Air transport
cmn	Communications: post and telecommunications
ofi	Other financial intermediation: includes auxiliary activities but not insurance and pension funding (see next)
isr	Insurance: includes pension funding, except compulsory social security
obs	Other business services: real estate, renting and business activities
ros	Recreation and other services: recreational, cultural and sporting activities, other service activities; private households with employed persons (servants)
osg	Other services (Government): public administration and defence; compulsory social security, education, health and social work, sewage and refuse disposal, sanitation and similar activities, activities of membership organizations n.e.c., extra-territorial organizations and bodies
dwe	Dwellings: ownership of dwellings (imputed rents of houses occupied by owners)

Source: GTAP, *www.gtap.agecon.purdue.edu/databases/contribute/detailedsector.asp*.

Part II.

What kind of policies support a dynamic comparative advantage?

Chapter 6

Comparative advantage and trade performance: Policy implications

by
Przemyslaw Kowalski[1]

This chapter establishes the relative importance of different sources of comparative advantage in explaining trade, with particular focus on policy and institutional factors. The policy and institutional areas shown to be important determinants of comparative advantage include physical and human capital accumulation (especially secondary and tertiary education), financial development, the business climate, as well as a number of aspects of labour market institutions. The results suggest that comparative advantage has been — and is likely to be in the future — relatively more important for North-South and South-South trade. Overall, the chapter concludes that when seeking to maintain or develop competitiveness in a certain area, it is best develop an effective broad policy approach.

For close to two centuries the comparative advantage hypothesis has been suggested as one of the principal explanations of international trade and, indeed, as one of the most potent explanations of higher incomes and income growth rates of open economies.[2] As such, the concept of comparative advantage had a strong influence on economic policy making in the post-WWII era, most notably the trade liberalisation initiatives under the auspices of the GATT and the WTO, regional integration initiatives as well as unilateral trade reforms, all of which placed emphasis on removing remaining trade barriers and facilitating trade-related structural adjustment, so that countries can benefit from comparative advantage-driven trade. There are controversies surrounding policy implications of the theory of comparative advantage. On the one hand, the theory indicates that an interference with comparative advantage, even if it entails government support to sectors in which a country may have "natural" comparative advantage, can reduce gains from trade or even render them negative (As argued in the Introduction to this volume). On the other hand, as pointed out by Rodrik (2009) even broad policies, not focused on any particular sector (e.g. education or capital market policies), may influence conditions for development of certain activities more than for others. What is then the "natural" comparative advantage? Can governments influence comparative advantage in a fashion that is sustainable and beneficial for the country and its trading partners?[3]

This chapter makes the first necessary step to answer some of these fundamental questions. It does so by: (i) estimating the extent to which comparative advantage may determine trade flows today as well as how this may have changed over time; (ii) establishing the relative importance of different sources of comparative advantage in explaining trade, with particular focus on policy and institutional factors; and (iii) drawing policy conclusions.

Sources of comparative advantage

Recent generalisations of comparative advantage, referred to by Helpman (2010) as "new sources of comparative advantage," focus strongly on the interaction of policies and regulatory frameworks with specific needs of particular sectors of the economy. For example, building on the seminal paper on the importance of financial institutions for development by Rajan and Zingales (1998), Beck (2003) and Manova (2008) showed that countries with better financial development export more in sectors that tend to rely more on external financing. Countries with better rule of law have been shown to export relatively more in sectors that have: lower levels of input concentration (Levchenko, 2007); lower shares of customised inputs (Nunn, 2007); or have higher levels of job task complexity (Costinot, 2009). Cunat and Melitz (2007) demonstrated that flexible labour market policies promote exports in industries characterised by higher volatility of demand.

This chapter builds on recent generalisations of theory and empirics of comparative advantage (e.g. Costinot, 2009; and Chor, 2010) as well as on numerous insights from the literature on specific sources of comparative advantage to quantitatively assess their relative importance for bilateral trade patterns at the industry level, with particular focus on policy and institutional factors. In this respect, the study offers the most extensive coverage of geographical, policy and institutional sources of comparative advantage in the existing literature. The policy and institutional areas posited as sources of comparative advantage in this chapter include physical and human capital endowments (distinguishing between secondary, tertiary education and average years of schooling), financial development, energy supply, doing business climate, a number of aspects of functioning of labour markets as well as import tariff policy. To assure global coverage and to make intra-OECD and extra-OECD comparisons the exercise is performed on a group of 55 OECD and selected emerging market (SEM) economies. In addition to providing insights on relative importance of different sources of comparative advantage in general, the approach allows cross-country assessment of differences in country characteristics and of potential impact on trade flows of future changes in these characteristics across the OECD and SEM economies.

Empirical methodology

The empirical model

The empirical methodology employed in this chapter is based on Chor (2010) who extends the aggregate Eaton-Kortum model of trade (Eaton and Kortum, 2002) to account for industry trade flows. In Chor (2010) the non-random component of productivity level of firms operating in a given industry is determined by the interaction between country and industry characteristics. He motivates this approach in the following way: "industries vary in the factors and institutional conditions that they need for production, and countries differ in their ability to provide for these industry-specific requirements." The interaction approach draws on classical trade theories as well as on the recent body of empirical literature dealing with individual institutional sources of comparative advantage. For instance, Romalis (2004) interacted country-level measures of factor abundance with industry-level measures of factor intensities, as posited by the Hecksher-Ohlin-Samuelson theory. Braun (2003), Beck (2003) and Manova (2008) interacted country measures of credit availability with industry measures of dependence on external financing. Levchenko (2007) interacted a measure of input concentration with indicators measuring the quality of the rule of law. Nunn (2007) and Costinot (2009) conducted similar analyses of the rule of law using, respectively, measures of share of customised inputs and of job task complexity. Cunat and Melitz (2007) interacted a measure of labour market flexibility with a measure of industry sales volatility.

Modifying Chor's notation to facilitate exposition the empirical model of bilateral exports at the industry level can be defined as follows:

$$ln(X_{ijt}^{k}) = \alpha + \partial_i + \partial_{jt}^{k} + \rho \ln\left(dist_{ij}\right) + \vartheta\left(lang_{ij}\right) + \mu\left(border_{ij}\right) + \varphi\left(colony_{ij}\right) + \quad (1)$$

$$+\beta_1 \left(\frac{K}{L}\right)_{it} \times KINT^k + \beta_2 P_{2it} \times {PD_2}^k + \cdots + \beta_N P_{Nit} \times {PD_N}^k + {\varepsilon_{ijt}}^k$$

where X_{ijt}^{k} are exports of industry k from country i to country j in year t. ∂_i and ∂_{jt}^{k} are, respectively, exporter fixed effects and importer-product-year fixed effects. The former type of fixed effects allow us to capture all unobserved exporter characteristics that are not interacted with any industry characteristics (such as the size of exporter's GDP, its GDP per capita or exchange rate). The latter type of fixed effect terms account for all unobserved importer-product-year characteristics and in particular for any unobserved demand or, indeed, comparative advantage factors specific to a particular importer (e.g. the fact that a certain importer is an exceptionally significant demander of a specific commodity). With such a specification of fixed effects the variation in bilateral exports at industry level is left to be explained by relative differences in exporters' abilities to produce certain goods which stem from interactions of exporter's i characteristics with characteristics of industry k, as well bilateral factors such as distance $\ln\left(dist_{ij}\right)$, common language($lang_{ij}$), common border($border_{ij}$), colonial relationship ($colony_{ij}$), which offer a natural benchmark for comparison of impacts for the policy and institutional variables.

The endowment, policy and institutional interaction terms are presented in the second line of equation (1) with $\left(\frac{K}{L}\right)_{it} \times KINT^k$ signifying the interaction of physical (or human) capital-to-labour ratios in exporter *i* in year *t* with physical (or human) capital-intensity of sector k. The interactive terms $P_{Nit} \times PD_N{}^k$ signify interaction between the indictor of *n-th* institution or policy for exporter i in year t with an indicator of dependence of sector k on institution or policy n. One example of such an interaction from the existing literature would be an interaction of the World Bank index of labour market flexibility with an industry-level indicator of sales demand volatility as in Cunat and Melitz (2007).

Equation (1) embeds several earlier empirical specifications of determinants of exports proposed by the literature (e.g. the gravity model of trade) and allows including as many country and industry interactions as one is capable of measuring and handling econometrically. The approach decomposes determinants of trade flows and allows capturing how well the conditions in country i provide for the production needs of industry k. Consequently, estimation of parameters of equation (1) allows assessing the relative importance of various sources of comparative advantage in the sample. For instance, it allows determining whether differences in physical capital-to-labour ratios across the sample have been more important in determining the industry pattern of trade flows as compared to differences in financial development. In addition, the estimated parameters can be interpreted in the context of cross-country variation in country characteristics to shed light on trade implications of any potential future changes in these country characteristics on a *ceteris paribus* basis (e.g. trade effects of aligning a given country's policy with an average or with the level of best performing peers).

Measurement of comparative advantage

A number of structural and, more recently, institutional and policy sources of comparative advantage have been identified in the literature. This section briefly summarises this literature as it relates to the sources of comparative advantage accounted for in the empirical exercise and justifies the data choices made.

The theory of comparative advantage indicates that specialisation according to comparative advantage is a precondition for reaping gains from trade. Any substantive interference with this process, even if it entails government support to sectors in which a country may have "natural" comparative advantage, can reduce these gains or even render them negative (see also Chapter 1). To reflect this, the empirical work presented in this chapter tries to get as close as it is possible to capturing the 'natural' comparative advantage. That is, we account for policies that do not target any particular sectors but rather reflect broad public choices or seek to enhance general resource endowments, even though they may indirectly favour some of the sectors. These broad policies are a potential source of comparative advantage and thus of welfare gains from trade. For example, capital accumulation can be encouraged by well developed financial markets and this can create favourable conditions for development of a competitive capital-intensive activity, but financial market reforms are not principally designed to favour any particular industry. Similarly, a good education system may boost the endowment of human capital thus favouring human-capital intensive activities, but good education policy does not directly favour production of any particular good or service.

Given the lack of conclusive evidence on viability of targeted industrial policies in sustainably influencing comparative advantage we exclude these policies as ones potentially hindering or reducing the gains from trade (Box 6.1).

Box 6.1. The debate on targeted industrial policy

As discussed in more detail in Chapter 3, the industrial policy, or infant industry, arguments posit that because of dynamic considerations, externalities, or large fixed costs, an economically viable industry would not be established by private agents in the absence of some form of help or a subsidy from government. Thus, with a targeted support the government can and should correct these negative externalities.

Yet, this proposition proved extremely controversial. The Washington Consensus of the early 1980s has led to promotion of structural adjustment programmes which promoted the power of markets over states in resource allocation and dismantling of policy regimes which were designed to promote industrial policy (Barnes *et al*., 2003). Some research inquiries that revisited this concept in the light of unprecedented performance of some Asian economies concluded that targeted industrial policies had been a failure and that the only viable role Asian governments had played was to promote economy-wide initiatives to correct market failures (World Bank, 1993).

However, this negative conclusion has also questioned (e.g. Lall, 1994; Rodrik, 1994; Stilglitz, 1996). In a recent survey Rodrik (2009) takes stock of the industrial policy debate and argues that there is a strong theoretical case for it based on correcting market imperfections. Rodrik argues that the case against it does not address the central premise of the need or government's ability to help an industry become viable in certain circumstances, but rather rests on practical difficulties with its implementation. Firstly, governments may be incapable of correctly identifying the "winners" and, secondly, industrial policy may trigger unwanted rent-seeking behaviour. These potential problems have been identified as particularly dangerous for developing countries which would like to emulate the benefits obtained from industrial policy by some Asian economies but which do not have as capable bureaucracies and the political ability to withdraw stimulating measures at the right time (Pack, 2000).

Many cases of industrial policy have been documented in the literature. A positive account of South Africa's Motor Industry Development Programme has been given by Barnes *et al*. (2003). Chang in Lin and Chang (2009) described the four decades long protection of the Japanese car industry by high tariffs, direct and indirect subsidies and restrictions on foreign direct investment before it became competitive in the world markets. Nokia group was cross-subsidised by its sister companies before it started making profits (Lin and Chang, 2009). Korean state owned firm POSCO benefited from import substitution-type of policies and the Brazilian aircraft company Embraer was established and developed into a global competitor through state ownership and export subsidies (Rodrik, 2009).

However, a significant scepticism persists about whether such specific examples constitute a case for a general recommendation of targeted industrial policy. Overall, currently, the debate on industrial policy remains "hung up on the question should we or should we not?" (Rodrik, 2009)

Factor intensities and factor endowments

Differences in relative factor endowments have been proposed as a source of comparative advantage in the Hecksher-Ohlin-Samuelson model of international trade.[4] A number of hypotheses identified within this framework find support in numerous empirical studies showing that countries tend to export products whose production requires a relatively intensive use of the factor of production in which they are relatively well endowed. Thus, for instance, a capital-abundant country would tend to export capital-intensive products and import labour-intensive products. Chapter 4, along with Debaere (2003), Romalis (2004), Chor (2010) are some of the studies that demonstrate that countries' relative endowments are informative of their pattern of trade.

The empirical model of trade developed in this chapter follows this literature by accounting for exporters' physical capital-to-labour ratios which are interacted with capital intensities measured at the industry level. Given the lack of readily available comprehensive time-series data on capital stocks for the 55 OECD and SEM economies considered in our study physical capital stocks series have been constructed according to the perpetual inventory method as $K_t = I_t + \delta K_{t-1}$ where I_t is gross fixed capital formation in year t and δ is the depreciation rate.[5] The Global Trade Analysis Project (GTAP) database values of physical capital stock in 2004 for each country have been taken as reference values while the data on gross fixed capital formation have been taken from the World Bank's World Development Indicators (WDI) database. Data on sectoral factor intensities come from the GTAP database and are defined as respective shares of individual endowments (skilled labour, unskilled labour and capital) in industry's total purchases of primary factors of production.[6]

Human capital intensity and education policy

In addition to physical capital the current study controls for human capital as a source of comparative advantage. The importance of human capital accumulation in economic performance has been studied by many economists. Lucas (1988) argued that human capital accumulation is the "engine of growth" citing the notable differences in productivity of human capital relative to the smaller differences in productivity of physical capital across countries. Romer (1990) and Barro (1991) carried out cross-sectional studies and found empirical support for the positive relationship between human capital accumulation and economic growth. Recently, Barro and Lee (2010) created a new data set of stocks of human capital based on educational attainment and found that length of schooling has a significant effect on output as well as income at the country level, particularly for secondary and tertiary levels of education. Some recent studies dealing with the impact of human capital accumulation on trade performance include Spiros and Riezman (2007), Manova (2008) and Spiros *et al*. (2009).[7]

The current exercise calculates the stocks and ratios of available human capital using the Barro and Lee (2010) data on percentages of population that have completed secondary and tertiary schooling combined with the WDI data on labour force as well as the Barro and Lee (2010) data on average years of study. To control for human capital as a source of comparative advantage in the presented empirical trade model these indicators of human capital are interacted with the skilled labour-intensity calculated at the level of manufacturing sector and defined as a share of skilled labour in industry's total purchases of primary factors of production. The distinction between tertiary and secondary education in Barro and Lee (2010) data allows a more nuanced analysis of relevance of education policy for trade outcomes in the discussion of results.

Dependence on external credit and availability of credit

Financial development has been established as a pre-condition for economic development. A seminal paper by Rajan and Zingales (1998) established that industrial sectors that are relatively more in need of external finance develop faster in countries with more developed financial markets. Beck (2003) and Manova (2008) built on this idea and demonstrated that financial development translates into a comparative advantage in industries that use more external finance. Beck (2003) demonstrated this effect using data for 36 industries and 56 countries. Manova (2008) showed how such an effect may arise in a theoretical trade model with heterogeneous firms where larger, more productive firms have an advantage in obtaining external finance. She also found empirical evidence for this effect using data on bilateral exports for 107 countries and 27 industries during the period 1985-1995. More recently Chor (2010) confirmed the importance of credit constraints as determinant of international trade patterns using a sample of 83 countries and 20 industries and data for 1990.

This chapter follows the approach initiated by Rajan and Zingales (1998) and adopted by Beck (2003), Manova (2008) and Chor (2010) to measure external capital dependence of a given industrial sector as the fraction of total capital expenditure not financed with cash flow from operations. The specific indicator of external capital dependence comes from Braun (2003) and is based on data for all publically traded US-based companies from Compustat's annual industrial files. One modification that had to be performed for the purposes of the current chapter was to match the 3-digit ISIC categories used by Braun (2003) with the GTAP sectoral classification.[8] Following Manova (2008) and Chor (2010) credit availability is measured as the WDI ratio of domestic credit to private sector to GDP, an indicator that has the best country and time coverage as far as our sample is concerned. This indicator of credit availability refers to financial resources provided to the private sector, such as through loans, purchases of nonequity securities, and trade credits and other accounts receivable, that establish a claim for repayment. For some countries these claims include credit to public enterprises.

While the choice of the indicator of dependence on external capital follows recent literature (e.g. Manova, 2008) and reflects the better availability of financial data for the US companies, it is possible that the US data may not be representative. One argument for using the US data is, as Manova (2009) argues, that the United States is characterised by one of the most advanced and sophisticated financial systems and that this makes it reasonable that the US indicators reflect firms' true demand for external capital. Using the US data is also convenient because it eliminates the potential for the measure of dependence on external finance to be endogenously determined by country's level of financial development or credit availability. However, the fact remains that the US indicators of dependence on external capital might not be representative of other countries, for example, those where government financing plays an important role. These caveats need to be born in mind when interpreting the results.

Energy intensity and energy supply

Producing goods and services requires the use of energy inputs, which tend to be scarce and often need to be imported. The shares of primary energy inputs in firms' costs vary across industries; naturally they tend to be large in sectors that produce processed energy products (e.g. *Petroleum and coal products* industry) but they are also large in some heavy industry sectors such as *Ferrous metals* and *Chemical, rubber and plastic products* or *Minerals* industries High reliance on energy inputs in these sectors means that they are vulnerable to energy price hikes as well as external supply-related pressures (i.e. reduction of supply leading to an increase in prices), in particular in the case of energy-importing countries. Differences in sectoral energy dependence as well as country characteristics in terms of primary energy supply policy can thus be an important source of comparative advantage.

After an extensive research on available energy policy indictors we chose to measure the extent of energy supply using the International Energy Agency (IEA) total primary energy supply (TPES) statistic scaled by the value of GDP. The IEA TPES measures total energy supply from a number of energy sources as found in their natural state, accounting for their calorific content of various energy commodities and converting it into a common unit of account (tonnes of oil equivalent). It equals production plus imports minus exports minus international marine bunkers plus or minus stock changes. The TPES-GDP ratios are calculated by dividing each country's annual TPES by each country's annual GDP expressed in constant 2000 prices and converted to US dollars using PPP for the year 2000.

The definition of TPES statistic refers to energy supply but in fact the statistic unavoidably reflects also demand factors, for example, through inclusion of energy imports. In fact, the TPES-to-GDP ratio is one of the most commonly used measures of energy intensity of economies, used extensively by the IEA, World Bank and general energy economics literature. An additional caveat is that, the measure can reflect a host of environmental and energy price policies, where countries with stricter energy use regimes or better technologies can record relatively lower TPES ratios. In light of these caveats, the interpretation of results based on this measure of energy supply should be approached carefully. We propose to interpret TPES-to-GDP ratio not as a strict measure of country relative natural endowment in energy sources but rather as a measure of general availability or affordability of energy in a given exporting economy. The proposed interaction term measuring sectoral dependence on energy is the ratio of total energy costs to the value of output in the given sector calculated from the input-output data available in the version 7 of the GTAP database.

Input concentration and business climate

The business climate's impact on economic growth and development has been the subject of a variety of recent studies many of which attempted to measure the impacts of various doing business indicators on aggregate trade performance. Only a few studies addressed the question of how the business climate can influence specialisation and structure of trade. Levchenko (2007) proposed that institutional quality can be a source of comparative advantage and analysed its impact on trade using a model that captures differences in institutional quality through a framework of incomplete contracts. The study proposed to proxy the industry-level dependence on institutional quality with a measure of input concentration as a proxy for product complexity and found that institutional aspects can significantly influence trade flows. Costinot (2009) identified the impact of institutional quality on the productivity of various sectors by taking into account different levels of job task complexity associated with production of different goods and found that especially in complex industries good institutions can be a complementary source of comparative advantage. Nunn (2007) analysed the impact of contract enforcement on exports in the context of industry differences in relation-specificity as proxied by shares of customized inputs. He found that good contract enforcement is especially important for the export performance of relationship-specific sectors and that this has a crucial impact on the pattern of trade: "contract enforcement explains more of the global pattern of trade than countries' endowments of physical capital and skilled labour combined" (Nunn, 2007, p.594). All of the above studies used inter alia the *rule of law* indicator from the *World Bank's Governance Indicators* database as a proxy for institutional quality.

The present chapter follows this literature and attempts to measure the extent of comparative advantage stemming from interactions of regulatory quality, as measured by country-level indicators of *regulatory quality*, *rule of law* and *control of corruption*, with product complexity, as measured by an industry-level indicator of intermediate input dispersion. The former three indicators are the components of the *World Bank's Governance Indicators* database that seem the most appropriate for measuring the quality of enforcement of commercial contracts.[9] The choice of the sector-dependence indicator follows Levchenko (2007) and Chor (2010) who proposed to measure the product complexity with the Herfindhal index of intermediate inputs dispersion. The index is calculated for the United States[10] based on input-output information from the version 7 of the GTAP database. The specific hypothesis is the one posited in the literature that the higher the intermediate input dispersion in a given industry (and thus the higher the complexity of products) the more important the quality of the legal framework for export performance.

Sales volatility and labour market rigidity

Cunat and Melitz (2007) proposed that differences across countries in labour market characteristics determine how firms adjust to idiosyncratic shocks and that they interact with sector-specific differences in demand volatility to generate a new source of comparative advantage. Specifically, they found that countries with more flexible labour markets tend to specialise in sectors with higher volatility of demand. This chapter follows this hypothesis and includes interactions of selected indicators of labour market regulation measured at the exporter level with an indicator of sectoral demand volatility.

There are a number of sources of information on labour market institutions including the subcategory of *World Bank Doing Business Database* on *Employing Workers* or the *OECD Indicators of Employment Protection*. However, country and time-coverage considerations as well as the extent of the covered detail and time variation in the data[11] led us to adopt indicators of regulation of labour markets developed by Botero (2004). This dataset covers legal rules in 85 countries in year 1997 and encompasses three types of laws: employment laws; collective relations; and social security laws, from which we retain the first two on the basis of more direct relevance of these laws for adjustment to economic shocks. *Employment laws* govern the individual employment contract. *Collective or industrial relations laws* regulate the bargaining, adoption, and enforcement of collective agreements, the organisation of trade unions, and the industrial action by workers and employers. As proposed by Cunat and Melitz (2007) these regulations may impose rigidities and prevent markets from adjusting to economic shocks by raising the cost for firms to hire workers and the cost of adjusting employment levels. For example, laws that raise the cost of employment adjustment, in particular those related to employment protection tend to reduce the inflow into unemployment, make firms more careful about hiring employees, and reduce the flow out of unemployment.

The following measures of labour regulation from Botero *et al.* (2004) are used in our study. *Alternative contracts* measures the existence and cost of alternatives to the standard employment contract. *Cost of increasing hours worked* measures the cost of increasing the number of hours worked. *Cost of firing workers* measures the cost of firing 20% of the firm's workers. *Dismissal Procedures* measures worker protection granted by law or mandatory collective agreements against dismissal. *Labour Union Power* measures the statutory protection and power of unions as the average of seven indicator variables indicating the presence of absence of various unionization rights and obligations. *Collective Disputes* measures the protection of workers during collective disputes as the average of eight more detailed indicator variables measuring presence or laws protecting industrial action. All of these indicators are constructed so that a higher indicator marks more rigid regulations. The adopted measure of sector-level sales volatility comes from

Braun (2003) who estimated sales volatility using data for all publically traded US-based companies from Compustat's annual industrial files.[12]

Imported intermediate inputs and import tariff policy

The final source of comparative advantage investigated in this chapter concerns tariff protection and its impact on imports of intermediate inputs. Miroudot *et al*. (2009) estimate that trade in intermediate inputs represents respectively 56% and 73% of overall trade flows in goods and services and takes place mostly among developed countries. They also find that in comparison to trade in final goods, imports of intermediates are more sensitive to trade costs. It is also a fact that industries differ with respect to ratios of values of imported intermediate inputs to the value of production with *Petroleum and coal products* as well as *Electronic equipment* industries recording the highest shares. It is thus proposed that the general level of tariff protection may constitute a source of comparative advantage with less protected economies having an advantage in sectors with high shares of imported intermediate inputs.

To account for such a possibility the level of average applied tariffs (from the *UN TRAINS* database) imposed by a given exporter is interacted with industry dependence on imported intermediate inputs. The latter is defined as the ratio of the value of imported intermediate inputs to the value of output in a given industry and calculated on the basis of the input-output data available from version 7 of the GTAP database. It is worth emphasising that the direct effects of import tariffs faced by exporters in destination markets are accounted for implicitly by the importer-product-year fixed effects (∂_{jt}^{k}) and thus should not bias other estimates. The import tariff variable used explicitly in our empirical model captures any impact a restrictive import regime may have on relative costs of production across sectors in the country that imposes the tariff. Thus, the estimated coefficients on tariff interaction terms should not be interpreted as measuring the impact of trade protection on trade in general but rather as measuring the extent to which high tariffs on imported intermediate inputs affect sectoral trade patterns.

Results

Data described in the previous section have been collected for 55 OECD and SEM economies for the period 1990-2009 but the coverage of policy and institutional determinants of comparative advantage is sometimes patchy. The choices of indicators described above already internalise some of the data availability constraints, with some of the proposed measures chosen on the basis of their time and country-coverage. In addition, 1995 and 2005 were selected as the years with the most consistent coverage of policies that also offer a comparison over a sensibly long time period. Thus, the empirical model is estimated separately as two cross sections for years 1995 and 2005 and jointly as a panel consisting of observations for 1995 and 2005 (i.e. including cross-sectional as well as time-series data). The existing empirical literature on institutional determinants of comparative advantage is based on cross-sectional estimations or on panels with short time spans so the addition of the time dimension in the current approach can be seen as an improvement.[13]

Instead of estimating the log-log version of model (1) we use the conditional Poisson fixed effects estimator with robust standard errors. This procedure uses the value of exports as the dependent variable and thus enables inclusion of observations for which bilateral trade is zero,[14] while at the same time yielding β coefficients that can be interpreted as elasticities (e.g. Dennis and Shepherd, 2007). The results of estimations for 1995, 2005 and the 1995-2005 panel are reported in, respectively, Tables 6.B1-B3. The significance of different sources of comparative advantage is established by estimating *individual models* involving all fixed effects and distance and geography variables and a specific institutional or policy variable (or a set of variables) (columns 2-16 in Tables 6.B1-6.B3) as well as by estimating *joint models* with all policy and distance and geography variables included in the same estimation (column 17 in Tables 6.B1-6.B3).[15]

What have been the main sources of comparative advantage in the last decade?

In most cases the present study confirms the main results from the recent literature on the importance of individual sources of comparative advantage. In addition, it contributes to this literature by offering comparisons of their relative importance within one consistent framework. The contribution that is the closest to the current one in terms of coverage of policy and institutional areas is Chor (2010). Chor's (2010) results for 1990 can be used to compare the importance of relative factor endowments, financial development, legal system and employment flexibility but the study does not cover the energy supply or import tariffs and its treatment of human capital and labour market rigidity is less detailed as compared to the current study.

To facilitate the interpretation of results and to establish which of the posited source of comparative advantage are more important in determining exports, we calculate standardised coefficients that capture the impact on exports of one standard deviation change in a given explanatory variable, relative to the impact of one standard deviation decrease in the logarithm of distance (Figure 6.1).[16] As such, the standardised coefficients combine the information on estimated elasticities presented in Tables 6.1-6.3 with the information on the extent of variation in explanatory variables in the underlying dataset. They can be interpreted as measures of relative importance of different explanatory variables in explaining export outcomes. To establish a benchmark, and taking France as an example, a one standard deviation decrease in the distance variable, equivalent to decreasing the distance between France and Slovakia to France and Switzerland[17] (i.e. by 62%) results in boosting exports by, on average, 53%.

It is important to keep in mind that in the considered model the variation in interaction terms is driven by both the variation in country characteristics (e.g. cross-country variation in years of schooling) as well as the variation in sector characteristics (e.g. cross-industry variation in skilled labour-intensity). As can be consulted in Figures 6.3-6.7 standard deviations in selected interaction terms calculated across all exporter-importer-industry observations are typically larger than standard deviations in policy indicators calculated across exporters.[18] Figure 6.2 accounts for this by presenting the estimated average impacts on exports of one standard deviation change in a given policy indicator calculated across exporters in 2005.

In general, estimations that consider policy and institutional factors one by one (*individual models*) yield results that are more "attractive" in terms of statistical significance, as compared to estimations that account for all factors at the same time (joint models). This is not entirely surprising since some policy indicators are correlated with each other resulting in various degrees of multicollinearity and problems with attributing variation in the dependent variable to variation in specific independent variables, which in turn is reflected in sign changes and reduction in statistical significance of estimated coefficients. Hence, in what follows the discussion of results considers both these types of estimates.

Factor intensities and factor endowments

The coefficients on interaction terms involving physical capital-to-labour ratios and capital intensities are either close to or larger than one (Figure 6.1) indicating that endowments of physical capital are at least equally as important in explaining industry patterns of trade as is geographical distance. The estimated *ceteris paribus* percentage impacts on exports of one standard deviation change in the capital-to-labour ratio are, depending on model specification, between 15 and 33% (Figure 6.2), suggesting a relatively large effect.

To give an example, one standard deviation increase in capital-to-labour ratio is equivalent to increasing the 2005 capital-to-labour ratio of Brazil to that of the Czech Republic or, equivalently, the one of the Czech Republic to that of Switzerland (Annex Figure 6.B1). These are important changes indicating a considerable degree of variation in capital-to-labour ratios across countries in our sample. Importantly, the so-called BRIIC countries (Brazil, Russia, India, Indonesia and China) record still some of the lowest capital-to-labour ratios in 2005 in the sample despite relative high investment rates in recent years. The importance of capital-to-labour ratios revealed by our estimations, the relatively low positioning of the BRIIC countries in the capital-to-labour ratio ranking at the end of the 2000s, and the high rates of income growth in recent decades combine to suggest that important changes in trade structures, such as an expansion of these countries' shares in exports of capital-intensive products, are likely to continue. This stresses the significance of policies that influence the pace and quality of physical capital accumulation.

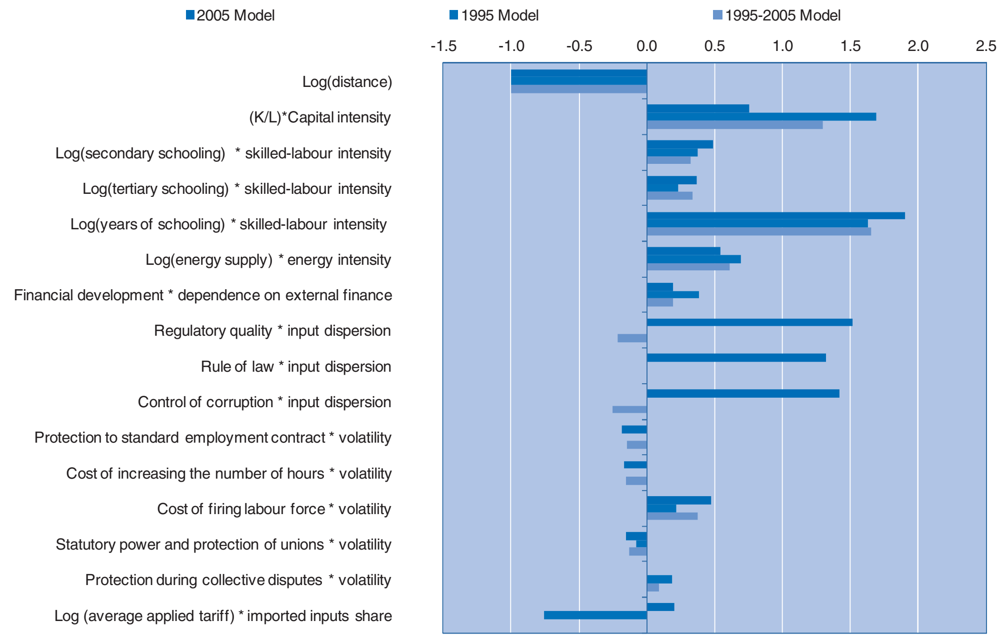
Human capital intensity and education policy

Estimated coefficients on stocks of available human capital and ratios of average years of schooling interacted with skilled labour-intensity reveal some of the most statistically significant and robust results. Standardised coefficients are around 0.4 and 0.3 for the stock of labour force with secondary and tertiary schooling, respectively, and about 1.5 for the average years of schooling variable. These coefficients indicate that the first two variables have a smaller power in terms of explaining variation in observed industry-level bilateral trade flows as compared to distance, while the variable indicating average years of schooling has twice as large explanatory power as the distance.

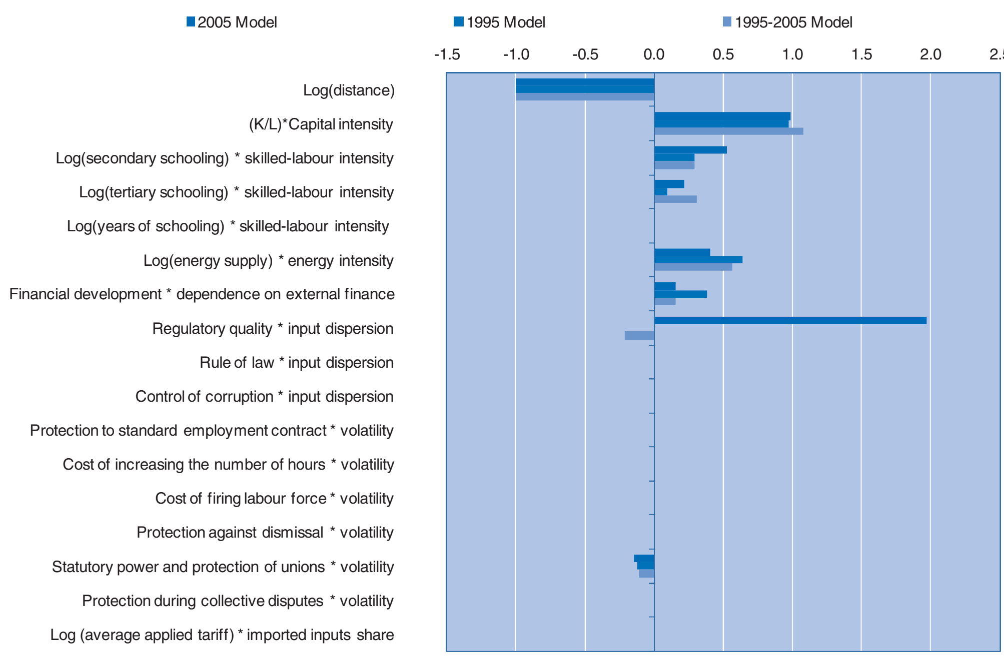
Standardised coefficients pertaining to the interaction of average years of schooling with skilled-labour intensity suggest that the length of schooling is one of the most important variable explaining industry patterns of trade flows (Figure 6.1). One standard deviation increase in years of schooling would on average result in about 14-17% increase in exports (Figure 6.2). This would be approximately equivalent to raising the average years of schooling in China or Brazil (the two countries that are close to the average level less one standard deviation – 7.6 and 7.2 years respectively) to the level of the United Kingdom or Italy (9.2 and 9.1 years respectively) or, equivalently, to raising the average number of years of schooling in the United Kingdom or Italy to the level of Germany or the United States (11.2 and 12.1 years respectively).

Figure 6.1. Standardised coefficients on policy and institutional determinants of comparative advantage: Impact on exports relative to the impact of one standard deviation increase in the log of distance

Panel A. Individual policy models
(corresponding to columns 2-16 in Tables 6.B1-6.B3)



Panel B. Joint policy model
(corresponding to column 17 in Tables 6.B1-6.B3)

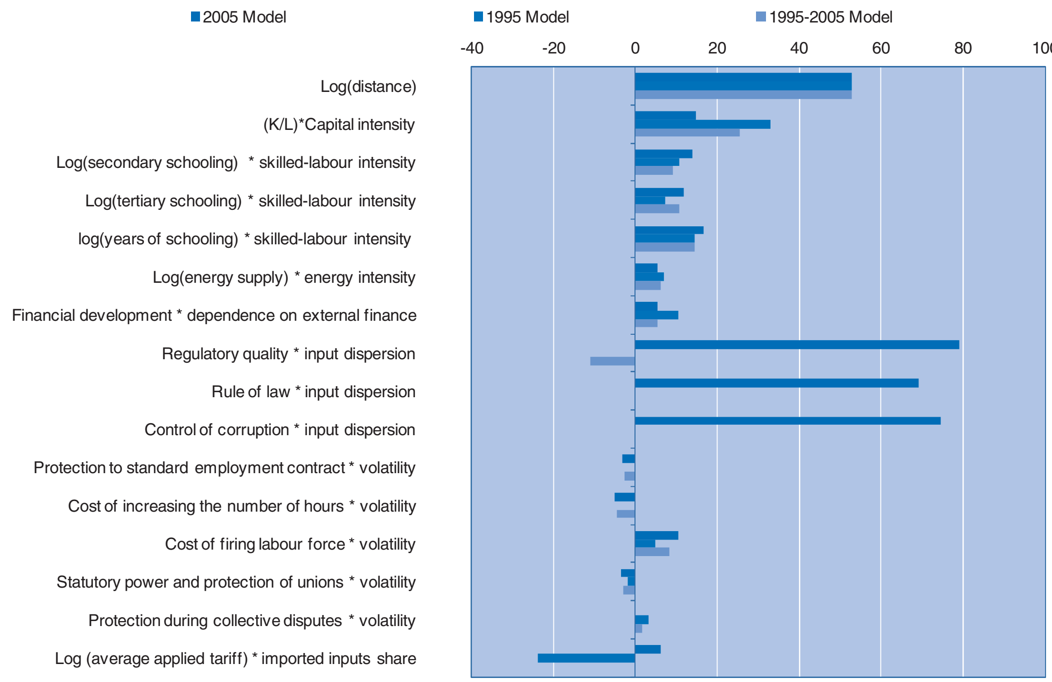


Only results statistically significant at 10% and stricter levels are reported.
Source: Author's calculations.

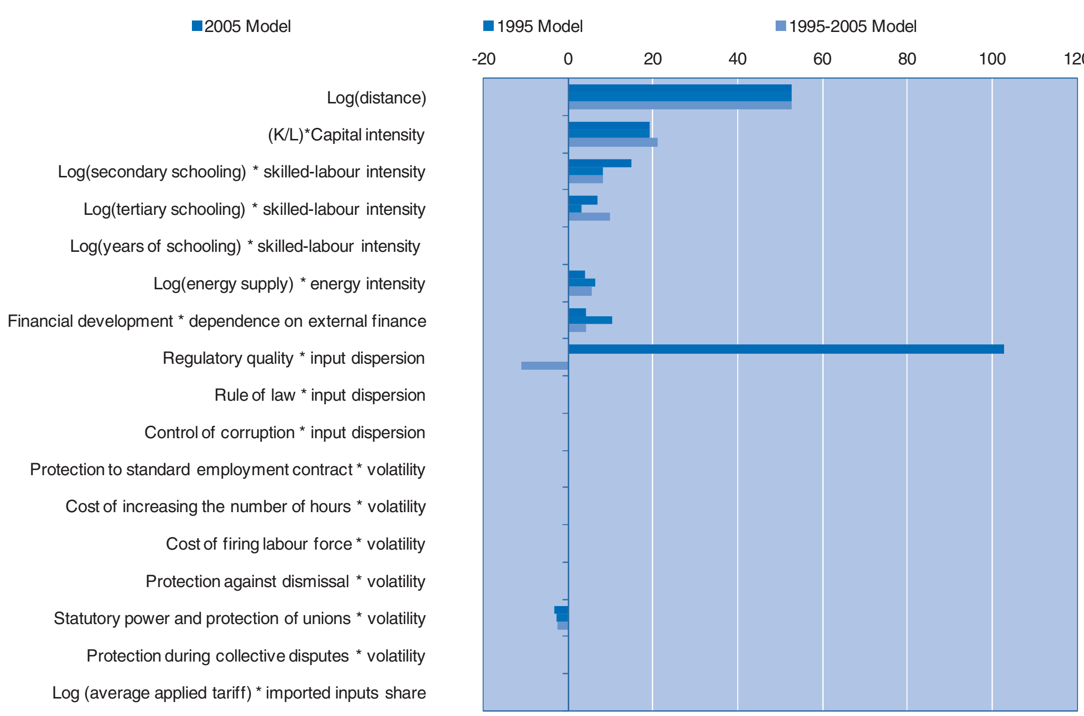
Figure 6.2 Average impacts of exports of one standard deviation change in policy indicator

Average % change in exports

Panel A. Individual policy models
(corresponding to columns 2-16 in Tables 6.B1-6.B3)



Panel B. Joint policy model
(corresponding to column 17 in Tables 6.B1-6.B3)



Source: Author's calculations.

Similarly to capital-to-labour ratios, the relatively low positioning of the BRIIC and other SEM economies in rankings of human capital indicators at the end of 2000s as well as the significant increases in recent decades suggest that important changes in trade structures, such as the expansion of these economies' shares in exports of human capital and technology-intensive products, associated with formation of human capital are likely to continue. This stresses the importance of policy environment that is conducive to human capital accumulation.

Interestingly, results for the impact of secondary and tertiary education indicate that the two types of education have different impacts on trade patterns. First, it is important to note that in contrast to average number of years of schooling, both these interaction terms capture the combined effect of the level of education as well as the size of the labour force (e.g. country with a smaller labour force will have a lower stock of labour force with secondary or tertiary education) and skilled labour-intensity of the sector. Nevertheless, standardised coefficients on secondary schooling interactions are higher than those on tertiary schooling in all model specifications. This indicates that cross-country differences in secondary schooling are a more important explanation of industry trade flows. Moreover, there is more variation across countries in secondary schooling (Annex Figure 6.B2) as compared to tertiary schooling (Annex Figure 6.B3). Interestingly, and in contrast to tertiary schooling, the differences have grown among OECD countries, while they have narrowed among non-OECD countries (Table 6.1). The gap between average OECD and average non-OECD score has also narrowed more quickly for secondary schooling than for tertiary schooling. Overall, our results suggest that differences in secondary schooling had a stronger influence on trade patterns in the past and that there is more potential for changes in secondary schooling policies to shape trade flows in the future and that they should be in the centre of attention of policy makers.

Dependence on external credit and credit availability

Credit availability proves to be another important source of comparative advantage, though the estimated impacts are smaller as compared to physical and human capital endowments. Coefficients are correctly signed and yield statistically significant results in all specifications of the model. The standardised coefficients for this variable are just below 0.20, i.e. of the size comparable to those pertaining to tertiary schooling (Figure 6.1). Nevertheless, cross-country variation in credit availability is relatively large and, as Figure 6.2 reveals, there is a relatively large potential for this source of comparative advantage to shape trade patterns in the future, especially as far as emerging economies are concerned (Table 6.1). It can be inferred that a one standard deviation change in the credit availability indicator would result in a 4% to 11% average increase in exports. Such a change is equivalent to increasing the 2005 ratio of domestic credit to private sector to GDP from the level observed in the Czech Republic (average less standard deviation) to the level observed in Italy or France (about average) or, equivalently, from the level observed in Italy or France to the level of Spain or Portugal (average plus one standard deviation).

Interestingly, the highest scores of credit availability in 2005 and in 1995 were recorded for some of the countries most severely affected by the dramatic tightening of credit in the early stages of the 2008-2009 and the 1997-1998 financial crises. For example, the two highest indicators of credit availability in 2005 are recorded for the United States and Iceland while Malaysia and Thailand were amongst the highest ranked countries in 1995 (Annex Figure 6.B5).This does not necessarily undermine our result that credit availability boosts exports more in sectors with higher dependence on external financing but rather points to the fact that credit squeezes similar to the ones observed during the 1997-1998 and 2008-2009 crises may have important implications for patterns of trade. In fact our results suggest an interesting and testable hypothesis that exports of external finance-dependent sectors could have been hit particularly hard in countries experiencing the toughest credit conditions in the aftermath of the recent crisis.

Energy intensity and energy supply

An in increase in energy supply is estimated to boost exports in relatively energy-intensive sectors though estimated impacts are somewhat smaller as compared to factor endowments or credit availability. Coefficients are correctly signed and highly significant in all model specifications. A one standard deviation increase in energy supply indicator could result in about 4 to 7% increase in exports, on average. Such an increase would be equivalent to increasing energy supply from the ratio observed in Israel in 2005 (average minus one standard deviation) to the level of Sweden (average) or equivalently from the level of Sweden to the level of Canada or Estonia (Annex Figure 6.B4).

This means that availability and affordability of energy can be an important determinant of export performance, a finding that that should certainly be deliberated together with environmental considerations associated with higher energy intensity.

Input concentration and doing business climate

The results on the impact of *regulatory quality*, *the rule of law* or *the control of corruption* on exports of industries with relatively high dispersion of intermediate inputs are mixed. The results are insignificant or incorrectly signed in models estimated as a cross-section for 1995 and as a 1995-2005 panel. The 2005 cross section yields expected signs and highly statistically significant point estimates with respect to these regulatory indicators. The higher significance of 2005 results could be explained by the fact that data on intermediate input concentration come from the GTAP database benchmarked to 2004, thus yielding a potentially more relevant correspondence between the sector characteristics, doing business indicators and observed trade flows. The 2005 estimates would indicate a very strong influence of this type of regulatory characteristics on industry trade patterns, with sectors characterised by higher dispersion of intermediate inputs exporting significantly more in countries with better regulations.

The standardised coefficients suggest that the importance of this source of comparative advantage can be compared to the impact of average years of schooling or indeed capital-to-labour ratios. The potential for future changes in trade patterns driven by changes in regulatory quality across countries would be equally as high. Our estimates indicate that, for example, moving up the 2005 regulatory quality in China (about average regulatory quality less one standard deviation) to the level of regulatory quality in Poland (about average) would bring about 80 to 103% average increase in Chinese exports. Equivalently, moving up the regulatory quality in Poland to the level observed in Denmark or the Netherlands (average plus one standard deviation) would be estimated to boost Polish exports on average by the same proportion.

Sales volatility and labour market rigidity

Some of the results pertaining to the impact on exports related to differences in labour market rigidities are statistically insignificant or counterintuitive. For example, estimations performed jointly for all policy areas do not yield significant results which may be related to the correlation of labour market indicators with other variables. The individual estimations yield correctly signed and consistently statistically significant results on *protection to standard employment contract, cost of increasing the number of hours worked* and *statutory power and protection of unions* having significantly negative effect on exports in industries characterised by relatively high levels of sales volatility. For example, one standard deviation increase in the indicator measuring protection of a standard employment contract would result in 3% decrease in exports. Such a change would be an equivalent of aligning regulations on protection of standard contract in Slovakia (average minus one standard deviation) to that in Hungary (approximately average) or of aligning protection of standard contract in Hungary with that of Finland (average plus one standard deviation). A one standard deviation increase in the indicator measuring cost of increasing the number of hours worked would result in 5% decrease in exports. This would be equivalent to increase the 2005 costs of increasing extra hours from those observed in the United Kingdom to those observed in Indonesia.

Imported intermediate inputs and import tariff policy

Results for the impact of import tariffs on exports of industries dependent on imported intermediate inputs do not yield robust results. While the individual model considering this policy area yields a relatively large and statistically significant negative impact for 1995, this result in not confirmed by the 2005 cross-sectional estimation or the 1995-2005 panel estimations. Neither is a statistically significant impact found when all policy areas are considered jointly. This leads us to conclude that import tariffs could not be established as an important source of comparative dis(advantage) given the adopted methodology. This result needs to be qualified to the extent that the presented approach explicitly accounts only for the impact of import tariffs on the pattern of exports of the tariff-imposing country while it does not directly measure the impact of import tariffs on the pattern of imports. This latter impact is accounted for implicitly in the importer-product-year fixed effects in equation (1). Thus, this result should not be interpreted as a lack of evidence of a negative effect of tariff protection on trade flows in general but rather as a lack of evidence of a significant impact of tariffs on imported intermediate inputs on trade patterns.

Has comparative advantage become less or more relevant for the trade of OECD and non-OECD countries?

The comparative advantage theory emphasises the relative differences between countries as the reason for international trade and, indeed, for gains from trade. The greater the differences in underlying sources of comparative advantage across countries, the larger the gains from trade. It is thus interesting to ask whether the countries in our sample have become more or less similar to each other during the last decade. Were this to be the case, the potential for gains from comparative advantage trade would have diminished. It is also interesting to investigate the evolution of these differences within and between the OECD and SEM groupings as an indication of changes in the potential for comparative advantage-driven gains from North-North, North-South and South-South trade.

Table 6.1 summarizes different basic measures of variation in indicators of sources of comparative advantage investigated in this chapter and presents some simple estimates of their convergence in time. Coefficients of variation, presented in Table 6.1, Panel A, suggest for example that a typical deviation from the average capital-to-labour ratio across the 55 countries has fallen from 64% to 58% of the mean. The results of conditional convergence regressions presented in the right-hand pane of Table 6.1, Panel A, shed more light on the speed and nature of changes in cross-country variation in these indicators.[19]

Comparing jointly across the OECD and SEM groupings for 1995 and 2005, we find that cross-country differences, and thus the potential for gains from comparative advantage-driven trade, decreased for *physical capital, average years of schooling, tertiary education, primary energy supply, availability of credit.* While this means that countries have become more similar as far as these factors are concerned and this reduced the potential for comparative advantage-driven trade, it also means that best performers in 1995 may have seen their comparative advantage erode in industries that use these resources relatively intensely. The conditional convergence regressions indicate that the so-called β-convergence, whereby worst performers improve their scores relatively quicker, has been an important part of this process and that it has been particularly fast for *availability of credit*, *average years of schooling and primary energy supply.*

At the same time there is no major change in cross-country variation for *secondary education* and, indeed, cross-country variation increases for *regulatory quality*, *rule of law*, *control of corruption* as well as *import tariffs*. This means that the potential for comparative advantage trade associated with these areas has actually increased. Thus, we can conclude, certain sources of comparative advantage have been eroded as countries have become more similar to each other, while others have actually expanded.

Table 6.1, Panel B, breaks up the sample into the OECD and non-OECD groupings in order to investigate the relevance of comparative advantage for trade within and between these groupings. It is interesting to note that the OECD grouping considered alone has become more homogenous as far as many country characteristics are concerned (*rule of law* and *control of corruption* remain largely unchanged), implying that the potential for comparative advantage-driven North-North trade may have diminished.

The non-OECD grouping, in addition to being generally more heterogeneous (e.g. 133% coefficient of variation for *physical capital-to-labour* ratios or 95% coefficient of variation for *tertiary schooling*), displayed no clear tendency for cross-country differences to diminish over time, indicating a persistently high potential for gains from comparative-advantage driven South-South trade. While differences diminished for *education*, *energy supply* and *financial development* indicators, there was no such tendency for *capital-to-labour ratios* or *regulatory indicators*.

As far as the potential for North-South trade is concerned, the widening differences between OECD and non-OECD for *physical capital*, *availability of credit* or *regulatory quality* suggest an increasing trade potential. However, differences between OECD and non-OECD have narrowed for *human capital* indicators (Table 6.1, Panel B). Overall, these results suggest that comparative advantage has been—and is likely to be in the future—relatively more important for North-South and South-South than for North-North trade.

Table 6.1. Convergence of comparative advantage sources

Panel A. Convergence across all countries in the sample

	Coefficient of variation		Estimated speed of convergence across all countries		
	Across all countries in 1995	Across all countries in 2005	β coefficient of convergence	Statistical significance	R2
K/L ratio	64%	58%	-0.06	***	0.15
Secondary schooling	46%	46%	-0.08	**	0.09
Tertiary schooling	64%	58%	-0.08	*	0.05
Years of schooling	26%	22%	-0.20	***	0.62
Energy supply	70%	58%	-0.15	***	0.25
Financial development	69%	62%	-0.42	***	0.34
Regulatory quality	32%	34%	-0.18	*	0.06
Rule of law	33%	37%	0.00		0
Control of corruption	37%	38%	-0.08	*	0.05
Average applied tariff	90%	98%	-0.42	***	0.26

Panel B. Convergence within OECD and non-OECD and between the groups

	Coefficients of variation				Non-OECD average as % of OECD average		
	Across OECD countries in 1995	Across OECD countries in 2005	Across non-OECD countries in 1995	Across non-OECD countries in 2005	1995	2005	Reduction in gap 2005-1995 (% points)
K/L ratio	61%	58%	132%	133%	21%	19%	-2%
Secondary schooling	35%	39%	61%	54%	64%	70%	6%
Tertiary schooling	45%	40%	95%	78%	44%	46%	1%
Years of schooling	16%	14%	31%	25%	69%	74%	4%
Energy supply	40%	32%	79%	63%	156%	158%	2%
Financial development	59%	52%	88%	69%	82%	57%	-25%
Regulatory quality	14%	12%	46%	47%	62%	56%	-6%
Rule of law	17%	18%	42%	50%	60%	55%	-5%
Control of corruption	17%	17%	52%	53%	55%	54%	-2%
Average applied tariff	50%	78%	66%	57%	290%	384%	95%

Coefficients of variations are standard deviations from the mean divided by respective means.
***, **, * denote respectively 1%, 5% and 10% levels of statistical significance.

Conclusions

This chapter builds on recent contributions to theory and empirics of comparative advantage and presents a quantitative assessment of relative importance of various sources of comparative advantage for bilateral trade flows of 55 OECD and SEM economies, with particular focus on policy and institutional factors. It follows the recent literature in emphasising the interaction between product and country characteristics, such as the interaction of policies and institutions with specific needs of sectors of the economy, that together form the basis for comparative advantage. In this respect, this chapter offers the most extensive coverage of policy and institutional and geographical sources of comparative advantage in the existing literature. The policy and institutional areas posited as determinants of comparative advantage in this chapter include physical capital accumulation, human capital accumulation (distinguishing between secondary, tertiary education and average years of schooling), financial development, energy supply, the business climate, a number of aspects of functioning of labour markets as well as import tariff policy.

Overall, the results show that comparative advantage remains an important determinant of trade. For example, *capital-to-labour ratios* are at least equally as important in explaining industry patterns of trade as is geographical distance. The cross-country differences in *secondary and tertiary education* provide approximately half of the explanatory power as compared to distance, while the indicator of *average years of schooling* has twice as large explanatory power as the distance variable. Other important sources of comparative advantage include the *availability of credit* and *primary energy supply* while *regulatory quality* and *labour market rigidity* tend to influence trade patterns less significantly.

The comparative advantage theory emphasises the relative differences in productivity between countries as the reason for international trade and hence for gains from trade. The larger the differences in underlying sources of comparative advantage across countries, the larger the gains from trade. Comparing jointly across the OECD and SEM groupings we find that cross-country differences, and thus the potential for gains from comparative advantage-driven trade, decreased for such sources of comparative advantage as: *physical capital, average years of schooling, tertiary education, primary energy supply, availability of credit*; while they increased for *secondary education* and *regulatory quality*.

The OECD grouping considered alone has become more homogenous as far as many comparative advantage sources are concerned, implying that the potential for comparative advantage-driven North-North trade may have diminished. The non-OECD grouping, in addition to being generally more heterogeneous, displayed no clear tendency for cross-country differences to diminish over time, indicating a persistently high potential for comparative advantage-driven South-South trade. The widening differences between OECD and non-OECD for *physical capital*, *availability of credit* or *regulatory quality* suggest an increasing potential for comparative advantage trade in North-South trade. However, differences between OECD and non-OECD have narrowed for *human capital* indicators. Overall these results suggest that comparative advantage has been—and is likely to be in the future—relatively more important for North-South and South-South trade than for North-North trade.

Our results show that comparative advantage remains an important determinant of trade and that it has changed over time, including as a result of changing policies and institutions. For example, the high explanatory power of *physical* or *human capital* revealed by our results underscores the significance of policies that influenced the pace and quality of physical and human capital accumulation. Similarly *availability of credit* has been found to boost exports more in sectors with higher dependence on external financing. An increase in *primary energy supply*-to-GDP ratio has been found to boost exports in relatively energy-intensive sectors.

Taken together, our results underscore the importance of a comprehensive approach to designing economic development policies which should seek consistency between trade and other policy objectives. Governments should avoid actively affecting trade patterns in general but such actions may be particularly counterproductive if they are inconsistent with country's resource base and other policies in place.

Thus, when seeking to maintain or develop competitiveness in a certain area—for instance *capital-intensive* sectors—this is best achieved through drawing on best practices and developing effective broad policies that facilitate capital accumulation. In case where a country succeeds in increasing its endowment of capital, relative to other countries and other factors of production, this is likely to result in the re-orientation of its exports toward *capital-intensive* sectors. Importantly, a broad-based approach involves a lower risk of reducing welfare gains from such specialisation, compared to policies involving direct support to capital-intensive sectors, though we certainly cannot exclude the possibility that the overall costs of such an approach exceed the benefits.

Moreover, the finding that comparative advantage has been evolving together with policies and institutions does not imply that countries should try to actively influence it. Instead, our results confirm that it is the differences between countries, including differences in policy settings and policy performance, that create relative differences in productivity and give rise to trade and gains from trade. Some of these differences in policy settings may reflect different stages of economic development but some may also reflect strategic policy choices, such as investment in human rather than physical capital. This does not mean that countries should not try to catch up with their best performing peers if they wish so, but it emphasises that trade yields benefits even at the early stages of such a catching-up process. More than anything, this implies that trade openness and comparative advantage-driven specialisation is not a constraint to the economic development process but rather its catalyst.

Notes

1. Trade Policy Analyst, Trade and Agriculture Directorate, OECD. This chapter has greatly benefited from consultations on empirical methodology with Patricia Sourdin and Ricardo H. Cavazos Cepeda, from the statistical assistance of Clarisse Legendre and from help with identification and collection of policy and sector dependence data by Ricardo H. Cavazos Cepeda, Isabel Hofmann, Anna Jankowska, Monika Sztajerowska and Zhang Bin. Material presented in this chapter is based on the work declassified by the OECD Working Party of the Trade Committee (Kowalski, 2011). It has also benefited from numerous comments on earlier drafts received at the OECD Enhanced Engagement Economies Working Meeting on the project, the OECD Global Forum on Globalisation, Comparative Advantage and Trade Policy Trade in Chengdu, China, the OECD Working Party of the Trade Committee and a number of internal OECD seminars. All the remaining errors and erroneous interpretations are the sole responsibility of the author.

2. According to the concept of comparative advantage productive resources of an open economy are directed towards sectors with the highest productivity, thereby raising aggregate productivity and income levels. There is strong empirical evidence that open economies enjoy higher level of incomes. Evidence on impact of trade on long-run rate of productivity growth is less conclusive (e.g. Nordas *et al*., 2006).

3. See, for example, Lin and Chang (2009) for a recent synopsis of the debate.

4. As explored in Chapter 4.

5. Results of these estimations are available upon request.

6. For more details on this and other data explanations, see OECD (2011).

7. Spiros and Riezman (2007) show that the skill level properties of human capital distribution directly impacts both the terms of trade as well as the effects of trade on inequality. Spiros *et al.* (2009) confirm the welfare enhancing impact of education policies in switching terms of trade and allowing countries to "move up the value chain." Manova (2008) measured the influence of human capital on trade patterns using data on the average number of years of schooling.

8. The matching is approximate as the GTAP classification is less aggregate as compared to the 3-digit ISIC. Hence, a number of GTAP sectors, particularly in the agro-food segment, are assumed to have the same degree of dependence on external capital (OECD, 2011).

9. The other three governance indicators included in this database are *voice and accountability*, *political stability* and *government effectiveness*.

10. It is a common approach in the related literature to take the United States as a benchmark.

11. The OECD data are only available for the OECD countries and a small number of non-member countries in 2008. The *Employing Workers* segment of the *WB Doing*

Business data is more aggregated as compared to Botero *et al.* (2004) and covers only the period 2004-2010.

12. The same data source has been used by Manova (2008). One modification that had to be performed for the purposes of the current chapter was to match the 3-digit ISIC categories used by Braun (2003) with the GTAP sectoral classification. See also endnote 9.

13. Cunat and Melitz (2007) estimate a cross section for 1996; Chor (2010) estimates a cross-section for 1990, Manova (2008) estimates a panel covering the 1985-1995 but has less extensive coverage of different institutional comparative advantage determinants.

14. Santo-Silva and Tenreyro (2006) highlight the importance of accounting for zero trade flows as well as addressing the form of heteroskedasticitiy inherent in the log-linearization of the multiplicative form of the gravity equation. This form of heteroskedasticity induces biases in the OLS estimator – thus rendering the resulting estimates unreliable for policy analysis. The Monte Carlo simulation results obtained in their paper show that the Poisson pseudo maximum likelihood estimator provides consistent estimates of the parameters of the gravity equation, while simultaneously ridding the model of the induced bias. In addition, since the model is estimated with the dependent variable in levels, rather than in logs, the problem of omitting zero trade is circumvented.

15. Some of the individual policy indicators are highly correlated with each other (e.g. the Governance Indicators) and cannot be included in the same regression because of the risk of multicollinearity. In such a case only one variable concerning this policy area is included. For example, regulatory quality and rule of law interactions are included separately in regressions (6-9) and only regulatory quality is included in the joint regression (column 17).

16. The choice of a comparator is not important for assessing relative impacts of other variables but comparisons with distance are interesting in themselves given the past rivalry between the neo-classical trade theory based on comparative advantage and the new trade theory based on increasing returns and integrating trade costs. Distance is also a natural comparator because of the highly significant and stable results it yields across various model specifications (Tables 6.A1-6.A3).

17. Switzerland is France's closest trading partner in our dataset. The measure of distance used in the current chapter is the population-weighted distance statistic from the CEPII Distances database. This is the distance between two countries based on bilateral distances between the biggest cities of those two countries, those inter-city distances being weighted by the share of the city in the overall country's population.

18. For a discussion of all interaction terms, see OECD (2011).

19. These estimations are based on a standard β-convergence regression: $\ln I_{t,i} - \ln I_{t-1,i} = \alpha + \beta \ln I_{t-1,i} + \varepsilon_t$ where $I_{t,i}$ is the value of indicator *I* (e.g. capital/labour ratio or average years of schooling) in period *t* in country *i*. negative estimate β indicates convergence and the size of the coefficient indicates the speed of convergence.

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Annex 6.A

Details of data

Distance and geography

Distances and *Gravity datasets* provided by the *Centre d'études prospectives et d'informations internationales* (CEPII).

Factor intensities and factor endowments

Industry characteristic: physical capital-intensity calculated as a share of capital in industry's total purchases of primary factors of production the GTAP version 7 database; averaged across all countries.

Country characteristic: exporters' physical capital-to-labour ratio using capital stocks series constructed according to the perpetual inventory method combining the GTAP version 7 database values of stock of physical capital in 2004 (the reference values) with gross fixed capital formation data from the World Bank's WDI database.

Human capital intensity and education policy

Industry characteristic: skilled labour-intensity calculated as a share of skilled labour in industry's total purchases of primary factors of production the GTAP version 7 database, averaged across all countries.

Country characteristic: stocks of labour force with completed secondary and tertiary schooling calculated using Barro and Lee (2010) data on percentages of population that have completed secondary and tertiary schooling combined with the WDI data on labour force. For average years of schooling, Barro and Lee (2010) data on average years of study.

Dependence on external credit and availability of credit

Industry characteristic: external capital dependence of a given industrial sector measured as the fraction of total capital expenditure not financed with cash flow from operations; from Braun (2003); based on data for all publically traded US-based companies from Compustat's annual industrial files; (approximately) concorded by the author from the 3-digit ISIC categories used by Braun (2003) to the GTAP sectoral classification.

Country characteristic: the WDI ratio of domestic credit to private sector to GDP covering financial resources provided to the private sector, such as through loans, purchases of nonequity securities, and trade credits and other accounts receivable, that establish a claim for repayment. For some countries these claims include credit to public enterprises.

Energy intensity and energy supply

Industry characteristic: share of primary energy inputs in firms' costs in the given industry; from version 7 of the GTAP database; average across all countries.

Country characteristic: International Energy Agency (IEA) total primary energy supply (TPES) statistics scaled by the value of GDP in 2000 prices and converted to US dollars using PPP for the year 2000.

Input concentration and business climate

Industry characteristic: Herfindhal index of intermediate inputs dispersion calculated for the United States; based on input-output data from the GTAP version 7 database.

Country characteristic: *regulatory quality*, *rule of law* and *control of corruption* indicators from the WB Governance Indicators database.

Sales volatility and labour market rigidity

Industry characteristic: sales volatility estimated using data for all publically traded US-based companies from Compustat's annual industrial files; from Braun (2003).

Country characteristic: measures of labour regulation from Botero *et al.* (2004); *Alternative contracts* measures the existence and cost of alternatives to the standard employment contract; *Cost of increasing hours worked* measures the cost of increasing the number of hours worked; *Cost of firing workers* measures the cost of firing 20% of the firm's workers; *Dismissal Procedures* measures worker protection granted by law or mandatory collective agreements against dismissal; *Labour Union Power* measures the statutory protection and power of unions as the average of seven indicator variables indicating the presence of absence of various unionization rights and obligations; *Collective Disputes* measures the protection of workers during collective disputes as the average of eight more detailed indicator variables measuring presence or laws protecting industrial action.

Imported intermediate inputs and import tariff policy

Industry characteristic: the ratio of value of imported intermediate inputs to the value of output in a given industry; based on input-output data from the GTAP version 7 database; averaged across all countries.

Country characteristic: average applied tariffs from the UN TRAINS database accessed through the World Integrated Trade Solution (WITS) database.

Country coverage

Countries covered: Argentina; Australia; Austria; Belgium; Brazil; Canada; Switzerland; Chile; China; Chinese Taipei; Czech Republic; Germany; Denmark; Egypt; Spain; Estonia; Finland; France; United Kingdom; Greece; Hong Kong, China; Hungary; Indonesia; India; Ireland; Iceland; Israel; Italy; Japan; Kazakhstan; Korea; Luxembourg; Morocco; Mexico; Malaysia; Nigeria; Netherlands; Norway; New Zealand; Poland; Portugal; Russian Federation; Saudi Arabia; Singapore; Slovak Republic; Slovenia; Sweden; Thailand; Tunisia; Turkey; Ukraine; United States; Venezuela; Viet Nam; South Africa.

Please note that the country coverage in specific regressions depends on data availability and may be less extensive than the one above.

Annex 6.B.

Table and figures

Table 6.B1. Conditional Poisson fixed effects regression model of industry trade flows for year 1995

(Dependent variable: value of exports)

	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)	(12)	(13)	(14)	(15)	(16)	(17)
Distance and geography																	
log(distance)	-0.780***	-0.789***	-0.793***	-0.790***	-0.791***	-0.815***	-0.789***	-0.789***	-0.789***	-0.835***	-0.833***	-0.838***	-0.834***	-0.836***	-0.835***	-0.828***	-0.867***
	(0.03)	(0.03)	(0.03)	(0.03)	(0.03)	(0.03)	(0.03)	(0.03)	(0.03)	(0.03)	(0.03)	(0.04)	(0.03)	(0.03)	(0.03)	(0.03)	(0.03)
border	0.542***	0.545***	0.545***	0.547***	0.545***	0.513***	0.545***	0.545***	0.545***	0.522***	0.523***	0.517***	0.523***	0.521***	0.523***	0.571***	0.525***
	(0.06)	(0.06)	(0.06)	(0.06)	(0.06)	(0.07)	(0.06)	(0.06)	(0.06)	(0.07)	(0.07)	(0.07)	(0.07)	(0.07)	(0.07)	(0.07)	(0.07)
common official language	0.401***	0.365***	0.355***	0.357***	0.372***	0.362***	0.365***	0.364***	0.365***	0.290***	0.288***	0.291***	0.290***	0.286***	0.296***	0.362***	0.332***
	(0.06)	(0.06)	(0.06)	(0.06)	(0.06)	(0.06)	(0.06)	(0.06)	(0.06)	(0.06)	(0.06)	(0.06)	(0.06)	(0.06)	(0.06)	(0.06)	(0.07)
colony	-0.239**	-0.234*	-0.229*	-0.225*	-0.237*	-0.114	-0.234*	-0.234*	-0.235*	-0.126	-0.125	-0.128	-0.125	-0.124	-0.128	-0.265**	-0.117
Hecksher-Ohlin	(0.09)	(0.10)	(0.09)	(0.09)	(0.10)	(0.09)	(0.10)	(0.10)	(0.10)	(0.10)	(0.09)	(0.10)	(0.09)	(0.09)	(0.10)	(0.09)	(0.09)
(K/L)*capital intensity		1.139***	0.990***	0.876***	1.271***	0.774***	1.128***	1.189***	1.164***	1.148***	1.156***	1.178***	1.142***	1.155***	1.148***	0.628*	0.659**
		(0.23)	(0.21)	(0.21)	(0.23)	(0.22)	(0.23)	(0.23)	(0.23)	(0.23)	(0.23)	(0.23)	(0.24)	(0.23)	(0.23)	(0.25)	(0.25)
Policy and instiutions																	
Human capital																	
log(secondary schooling) * skilled-labour intensity			0.013***														0.010***
			(0.00)														(0.00)
log(tertiary schooling) * skilled-labour intensity			0.021***														0.009
			(0.01)														(0.01)
log(years of schooling) * skilled-labour intensity				13.292***													
Energy				(1.76)													
log(energy supply) * energy intensity					3.335***												3.080***
Financial development					(0.49)												(0.48)
financial development * dependence on external finance						0.023***											0.023***
Doing business climate						(0.00)											(0.00)
regulatory quality * input concentration							-0.014										-0.024
							(0.02)										(0.03)
rule of law * input concentration								0.038									
								(0.02)									
control of corruption * input concentration									0.020								
Labour market institutions									(0.02)								
Protection of labour and employment laws																	
protection to standard employment contract * volatility										-0.120							0.150
										(0.14)							(0.10)
cost of increasing the number of hours * volatility											-0.142						
											(0.07)						
cost of firing labor force * volatility												0.379**					
												(0.14)					
protection against dismissal * volatility													-0.121				
Protection of collective relations laws													(0.13)				
statutory power and protection of unions * volatility														-0.139*			-0.226**
														(0.06)			(0.07)
protection during collective disputes * volatility															0.344**		
Import tariff policy															(0.11)		
log (average applied tariff) * imported inputs share																-3.451***	-1.154
																(0.50)	(0.72)
Exporter fixed effects	yes	yes	yes	yes	yes	yes	yes	yes	yes	yes	yes	yes	yes	yes	yes	yes	yes
Importer-industry fixed effects	yes	yes	yes	yes	yes	yes	yes	yes	yes	yes	yes	yes	yes	yes	yes	yes	yes
Number of observations	117 936	107 162	107 162	107 162	107 162	105 019	107 162	107 162	107 162	96 321	96 321	96 321	96 321	96 321	96 321	100 509	91 832

Robust standard errors by importer-product group, ***, ** and * denote statistical significance at 1%, 5% and 10% levels respectively, brackets contain standard errors.

Table 6.B2. Conditional Poisson fixed effects regression model of industry trade flows for year 2005
(Dependent variable: value of exports)

	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)	(12)	(13)	(14)	(15)	(16)	(17)
Distance and geography																	
log(distance)	-0.852***	-0.861***	-0.865***	-0.863***	-0.862***	-0.873***	-0.861***	-0.861***	-0.861***	-0.881***	-0.880***	-0.885***	-0.883***	-0.882***	-0.882***	-0.865***	-0.884***
	(0.04)	(0.04)	(0.03)	(0.03)	(0.04)	(0.03)	(0.03)	(0.04)	(0.03)	(0.04)	(0.03)	(0.04)	(0.04)	(0.04)	(0.04)	(0.03)	(0.03)
border	0.395***	0.401***	0.401***	0.400***	0.402***	0.399***	0.401***	0.400***	0.401***	0.413***	0.415***	0.409***	0.411***	0.412***	0.413***	0.443***	0.445***
	(0.08)	(0.07)	(0.07)	(0.07)	(0.07)	(0.07)	(0.07)	(0.07)	(0.07)	(0.07)	(0.07)	(0.07)	(0.07)	(0.07)	(0.07)	(0.07)	(0.07)
common official language	0.242**	0.171**	0.170**	0.175**	0.174**	0.154*	0.167*	0.167**	0.166*	0.119	0.118	0.117	0.122	0.116	0.122	0.159*	0.123
	(0.07)	(0.07)	(0.07)	(0.07)	(0.07)	(0.07)	(0.06)	(0.06)	(0.06)	(0.07)	(0.07)	(0.07)	(0.07)	(0.07)	(0.07)	(0.08)	(0.08)
colony	-0.101	-0.065	-0.059	-0.060	-0.068	0.045	-0.064	-0.065	-0.065	0.053	0.053	0.055	0.053	0.056	0.052	-0.066	0.052
Hecksher-Ohlin	(0.08)	(0.08)	(0.08)	(0.08)	(0.08)	(0.08)	(0.08)	(0.08)	(0.08)	(0.08)	(0.08)	(0.08)	(0.08)	(0.08)	(0.08)	(0.08)	(0.08)
(K/L)*capital intensity		0.492*	0.490*	0.465*	0.718**	0.324	0.784***	0.772***	0.806***	0.478*	0.492*	0.556*	0.489*	0.492*	0.480*	0.658**	0.648**
		(0.23)	(0.21)	(0.21)	(0.23)	(0.22)	(0.21)	(0.21)	(0.21)	(0.24)	(0.23)	(0.22)	(0.24)	(0.23)	(0.24)	(0.24)	(0.23)
Policy and instiutions																	
Human capital																	
log(secondary schooling) * skilled-labour intensity			0.014***														0.015***
			(0.00)														(0.00)
log(tertiary schooling) * skilled-labour intensity			0.029***														0.017*
			(0.01)														(0.01)
log(years of schooling) * skilled-labour intensity				14.908***													
Energy				(2.26)													
log(energy supply) * energy intensity					2.453***												1.821***
Financial development					(0.40)												(0.35)
financial development * dependence on external finance						0.009***											0.007***
Doing business climate						(0.00)											(0.00)
regulatory quality * input concentration							0.070**										0.091***
							(0.02)										(0.03)
rule of law * input concentration								0.058**									
								(0.02)									
control of corruption * input concentration									0.061***								
Labour market institutions									(0.02)								
Protection of labour and employment laws																	
protection to standard employment contract * volatility										-0.252**							-0.086
										(0.10)							(0.08)
cost of increasing the number of hours * volatility											-0.192**						
											(0.07)						
cost of firing labor force * volatility												0.837***					
												(0.12)					
protection against dismissal * volatility													0.109				
Protection of collective relations laws													(0.07)				
statutory power and protection of unions * volatility														-0.280***			-0.261***
														(0.07)			(0.07)
protection during collective disputes * volatility															0.071		
Import tariff policy															(0.09)		
log (average applied tariff) * imported inputs share																1.204*	-0.427
																(0.49)	(0.49)
Exporter fixed effects	yes	yes	yes	yes	yes	yes	yes	yes	yes	yes	yes	yes	yes	yes	yes	yes	yes
Importer-industry fixed effects	yes	yes	yes	yes	yes	yes	yes	yes	yes	yes	yes	yes	yes	yes	yes	yes	yes
Number of observations	124 470	113 096	113 096	113 096	113 096	108 573	113 096	113 096	113 096	101 740	101 740	101 740	101 740	101 740	101 740	105 989	94 630

Robust standard errors by importer-product group, ***, ** and * denote statistical significance at 1%, 5% and 10% levels respectively, brackets contain standard errors.

Table 6.B3. Conditional Poisson-fixed effects regression model of industry trade flows for two-year panel 1995-2005

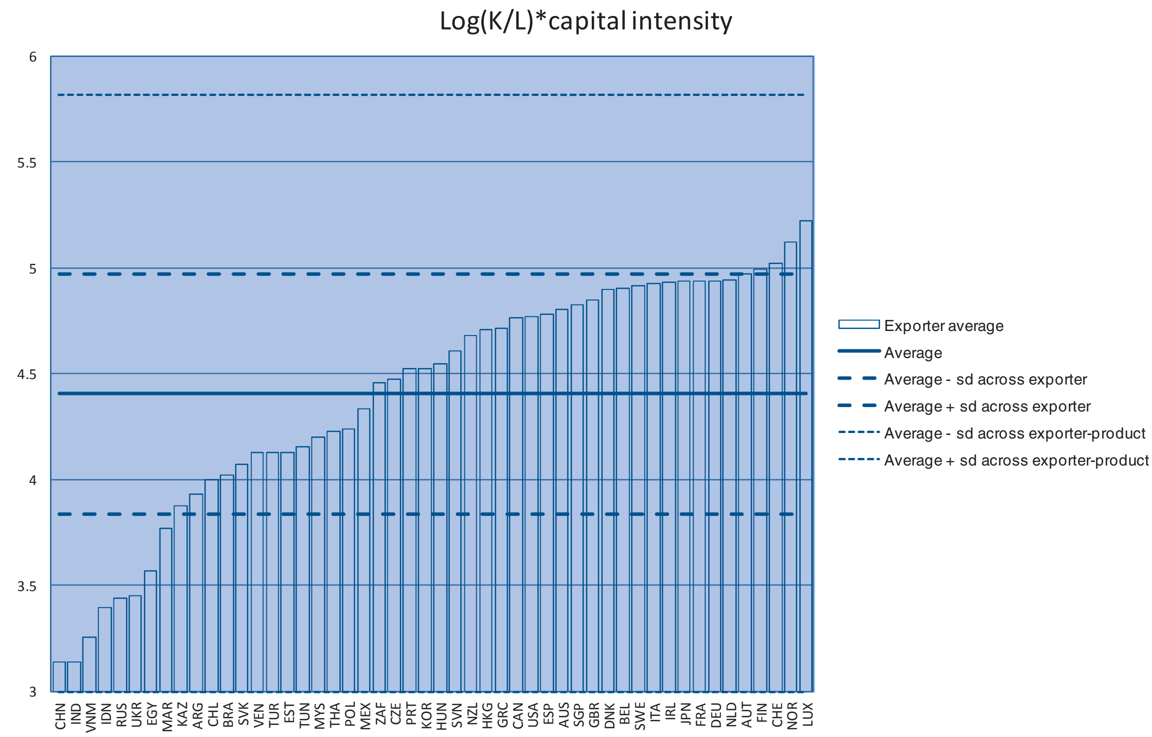
(Dependent variable: value of exports)

	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)	(12)	(13)	(14)	(15)	(16)	(17)
Distance and geography																	
log(distance)	-0.821***	-0.830***	-0.833***	-0.832***	-0.831***	-0.842***	-0.830***	-0.830***	-0.831***	-0.855***	-0.853***	-0.859***	-0.856***	-0.856***	-0.855***	-0.843***	-0.863***
	(0.03)	(0.03)	(0.03)	(0.03)	(0.03)	(0.03)	(0.03)	(0.03)	(0.03)	(0.03)	(0.03)	(0.03)	(0.03)	(0.03)	(0.03)	(0.03)	(0.03)
border	0.446***	0.452***	0.454***	0.452***	0.452***	0.446***	0.451***	0.451***	0.451***	0.459***	0.461***	0.454***	0.458***	0.458***	0.459***	0.491***	0.485***
	(0.06)	(0.05)	(0.05)	(0.05)	(0.05)	(0.05)	(0.05)	(0.05)	(0.05)	(0.05)	(0.05)	(0.05)	(0.05)	(0.05)	(0.05)	(0.05)	(0.05)
common official language	0.277***	0.218***	0.211***	0.215***	0.222***	0.206***	0.220***	0.218***	0.220***	0.157**	0.156**	0.156**	0.159**	0.154**	0.161**	0.199**	0.172**
	(0.06)	(0.05)	(0.05)	(0.05)	(0.05)	(0.06)	(0.05)	(0.05)	(0.05)	(0.06)	(0.06)	(0.05)	(0.06)	(0.06)	(0.06)	(0.06)	(0.07)
colony	-0.146*	-0.120	-0.116	-0.116	-0.124*	-0.012	-0.123*	-0.120	-0.121*	-0.003	-0.002	-0.003	-0.003	-0.000	-0.004	-0.127*	-0.008
Heckscher-Ohlin	(0.06)	(0.06)	(0.06)	(0.06)	(0.06)	(0.06)	(0.06)	(0.06)	(0.06)	(0.06)	(0.06)	(0.06)	(0.06)	(0.06)	(0.06)	(0.06)	(0.06)
(K/L)*capital intensity		0.862***	0.807***	0.804***	1.028***	0.681***	0.839***	0.874***	0.759***	0.866***	0.874***	0.914***	0.870***	0.875***	0.867***	0.785***	0.718***
		(0.14)	(0.13)	(0.13)	(0.14)	(0.13)	(0.14)	(0.13)	(0.15)	(0.14)	(0.14)	(0.14)	(0.14)	(0.14)	(0.14)	(0.14)	(0.14)
Policy and instiutions																	
Human capital																	
log(secondary schooling) * skilled-labour intensity			0.010***														0.009***
			(0.00)														(0.00)
log(tertiary schooling) * skilled-labour intensity			0.028***														0.026***
			(0.00)														(0.00)
log(years of schooling) * skilled-labour intensity				13.172***													
Energy				(1.28)													
log(energy supply) * energy intensity					2.851***												2.623***
Financial development					(0.35)												(0.35)
financial development * dependence on external finance						0.010***											0.008***
Doing business climate						(0.00)											(0.00)
regulatory quality * input concentration							-0.010*										-0.010*
							(0.00)										(0.00)
rule of law * input concentration								0.004									
								(0.01)									
control of corruption * input concentration									-0.011**								
Labour market institutions									(0.00)								
Protection of labour and employment laws																	
protection to standard employment contract * volatility										-0.207*							-0.030
										(0.08)							(0.06)
cost of increasing the number of hours * volatility											-0.176***						
											(0.05)						
cost of firing labor force * volatility												0.665***					
												(0.09)					
protection against dismissal * volatility													0.028				
Protection of collective relations laws													(0.06)				
statutory power and protection of unions * volatility														-0.231***			-0.196***
														(0.05)			(0.05)
protection during collective disputes * volatility															0.170*		
Import tariff policy															(0.07)		
log (average applied tariff) * imported inputs share																-0.093	-0.067
																(0.42)	(0.48)
Exporter fixed effects	yes	yes	yes	yes	yes	yes	yes	yes	yes	yes	yes	yes	yes	yes	yes	yes	yes
Importer-industry-year fixed effects	yes	yes	yes	yes	yes	yes	yes	yes	yes	yes	yes	yes	yes	yes	yes	yes	yes
Number of observations	242 406	220 258	220 258	220 258	220 258	213 592	220 258	220 258	220 258	198 061	198 061	198 061	198 061	198 061	198 061	206 498	186 462

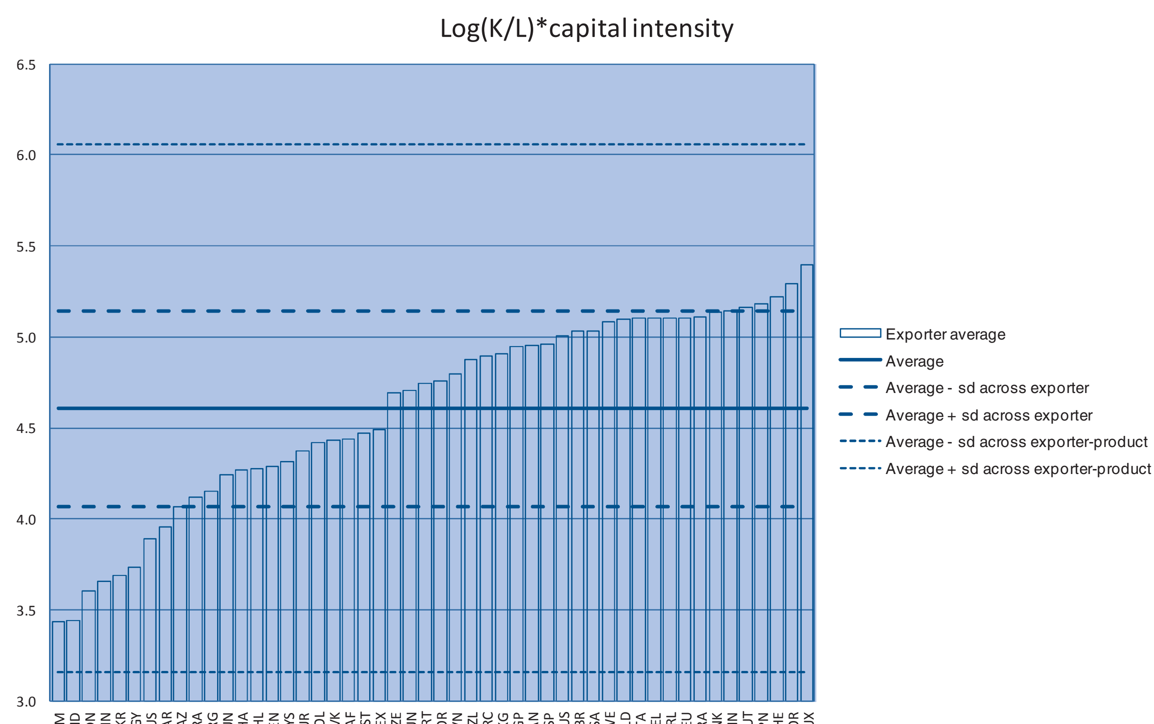
Robust standard errors by importer-product-year group, ***, ** and * denote statistical significance at 1%, 5% and 10% levels respectively, brackets contain standard errors.

Annex Figure 6.B1. Heckscher-Ohlin sources of comparative advantage: Variation across exporters and industries

1995



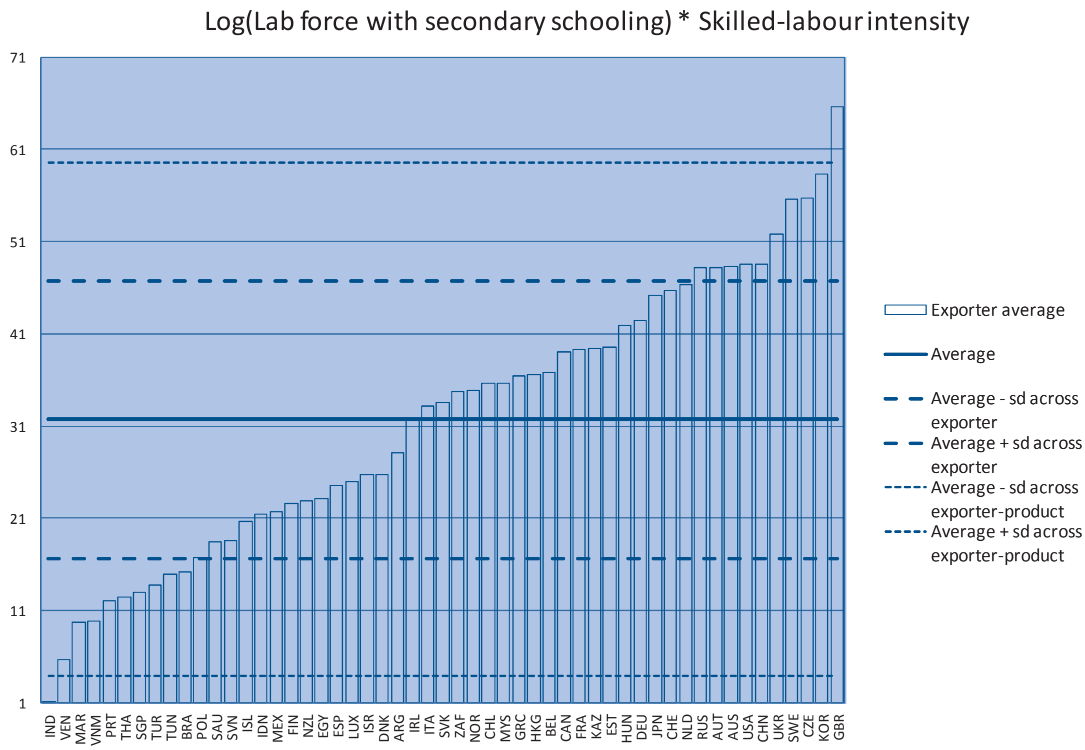
2005



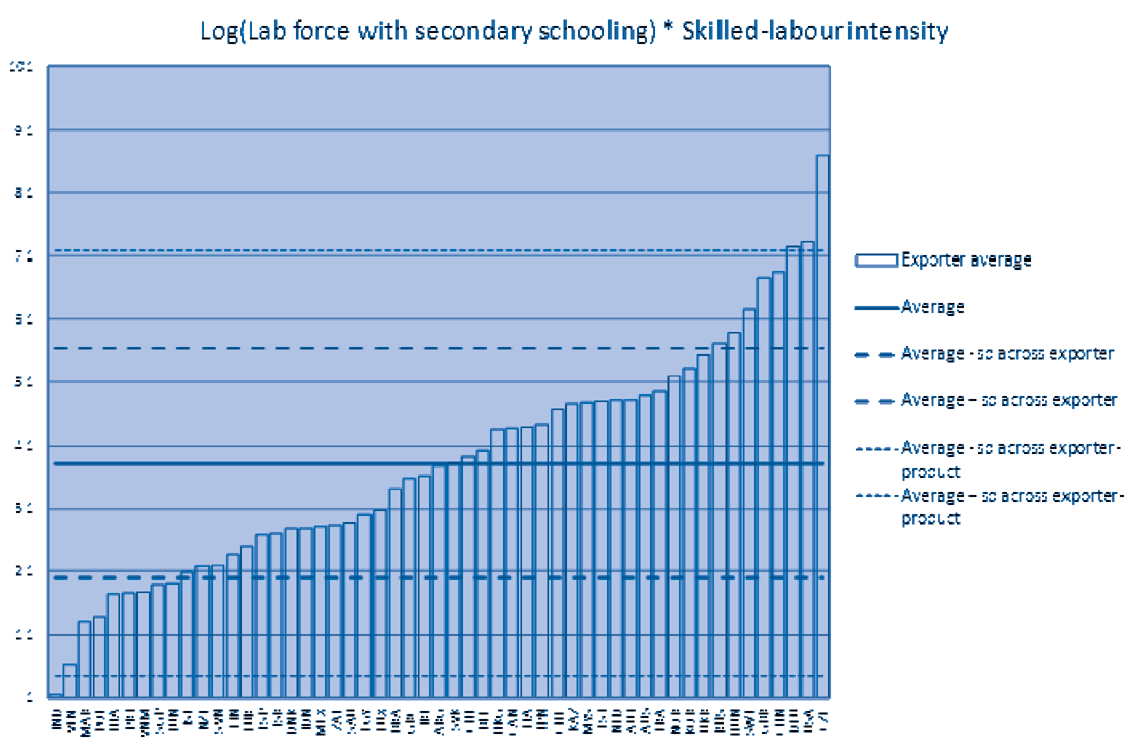
See variable definitions and sources in Annex 6.A.

Annex Figure 6.B2. Labour force with secondary schooling and skilled labour-intensity: Variation across exporters and industries

1995



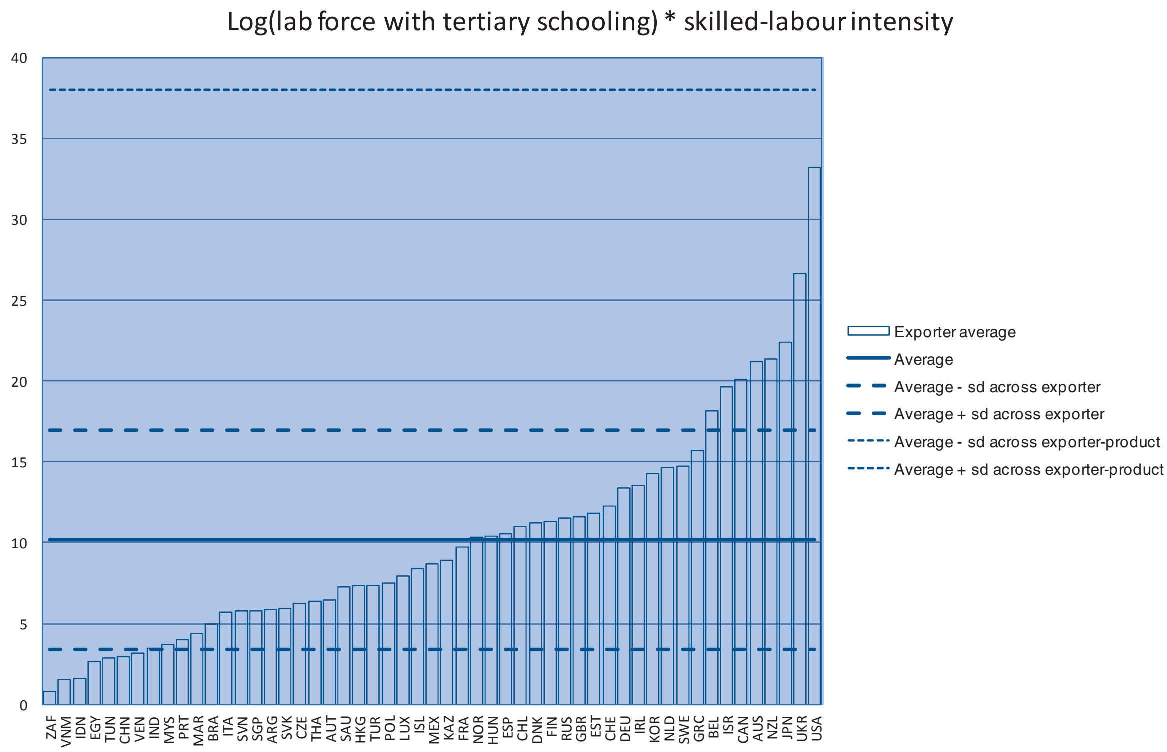
2005



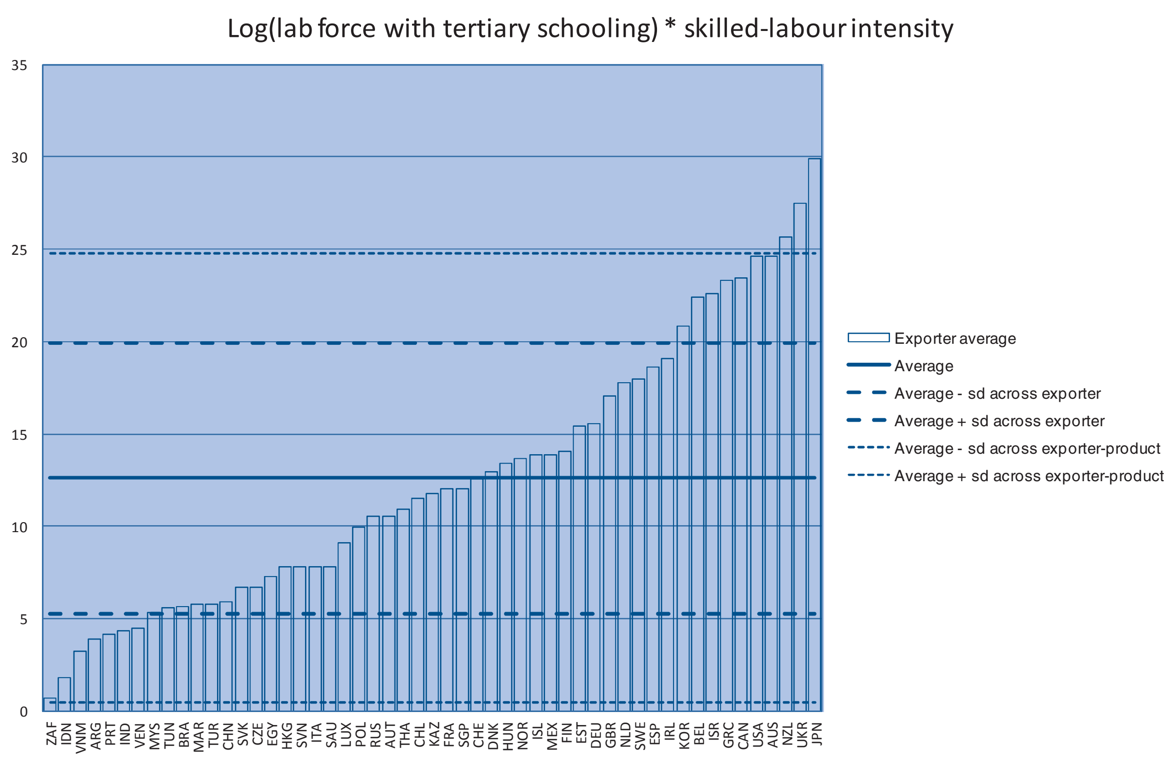
See variable definitions and sources in Annex 6.A.

Annex Figure 6.B3. Labour force with tertiary schooling and skilled labour-intensity: Variation across exporters and industries

1995



2005

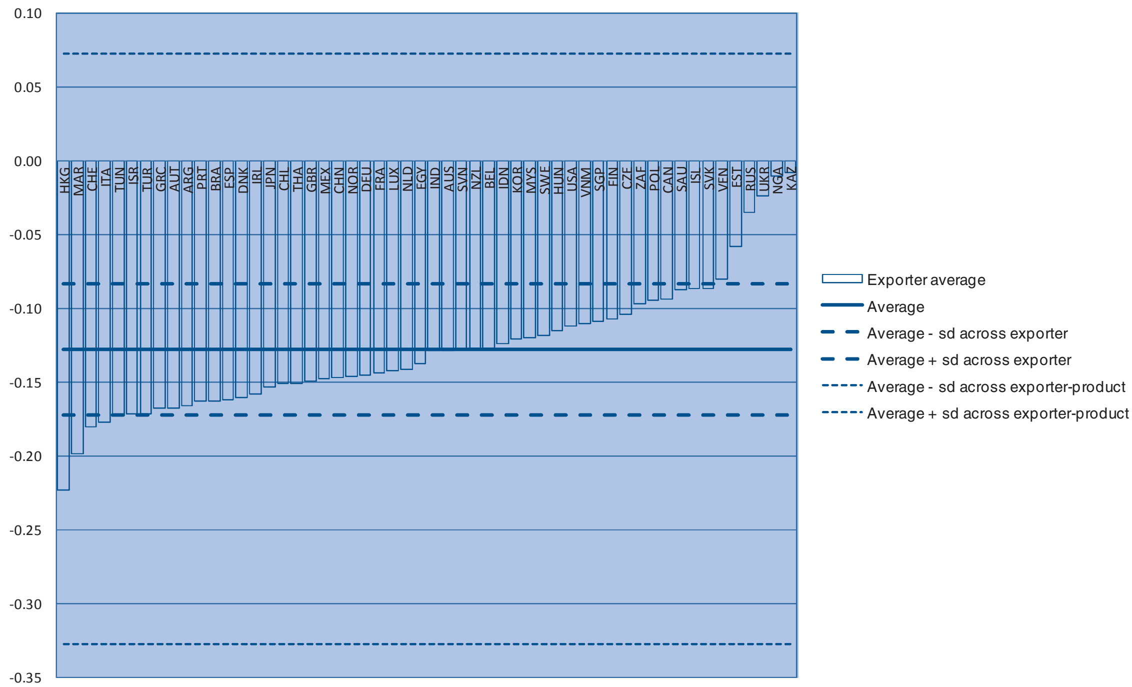


See variable definitions and sources in Annex 6.A.

Annex Figure 6.B4. Energy supply and energy-intensity: Variation across exporters and industries

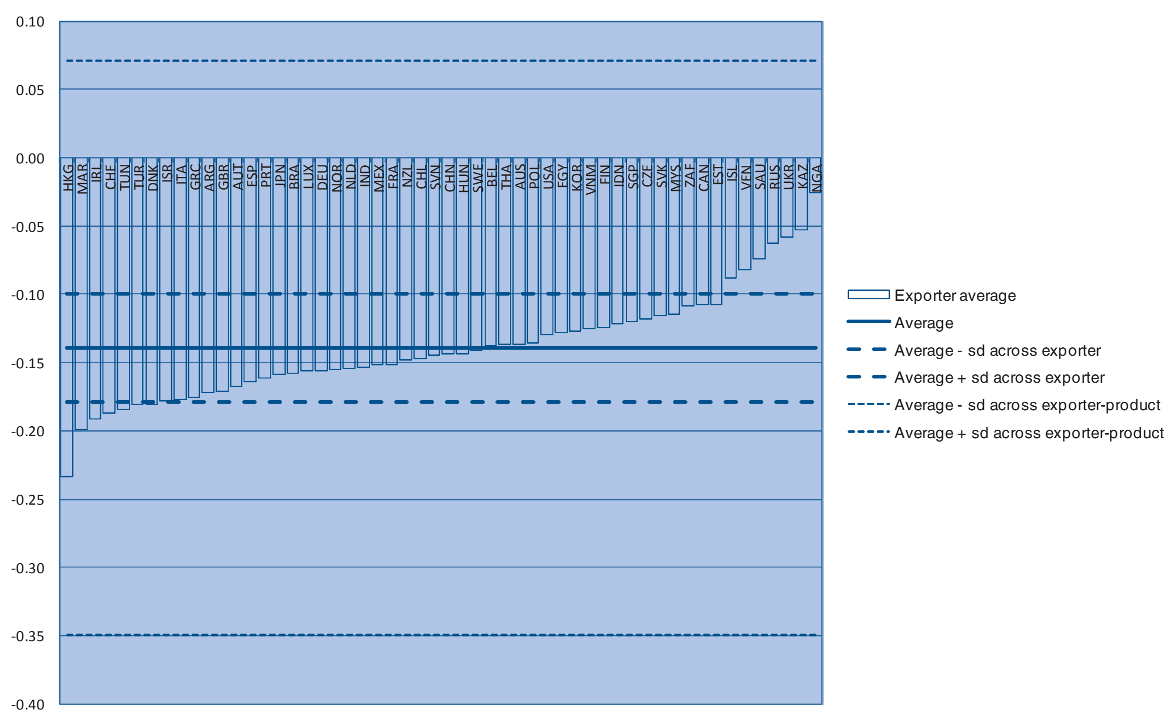
1995

Log(energy supply) * energy intensity



2005

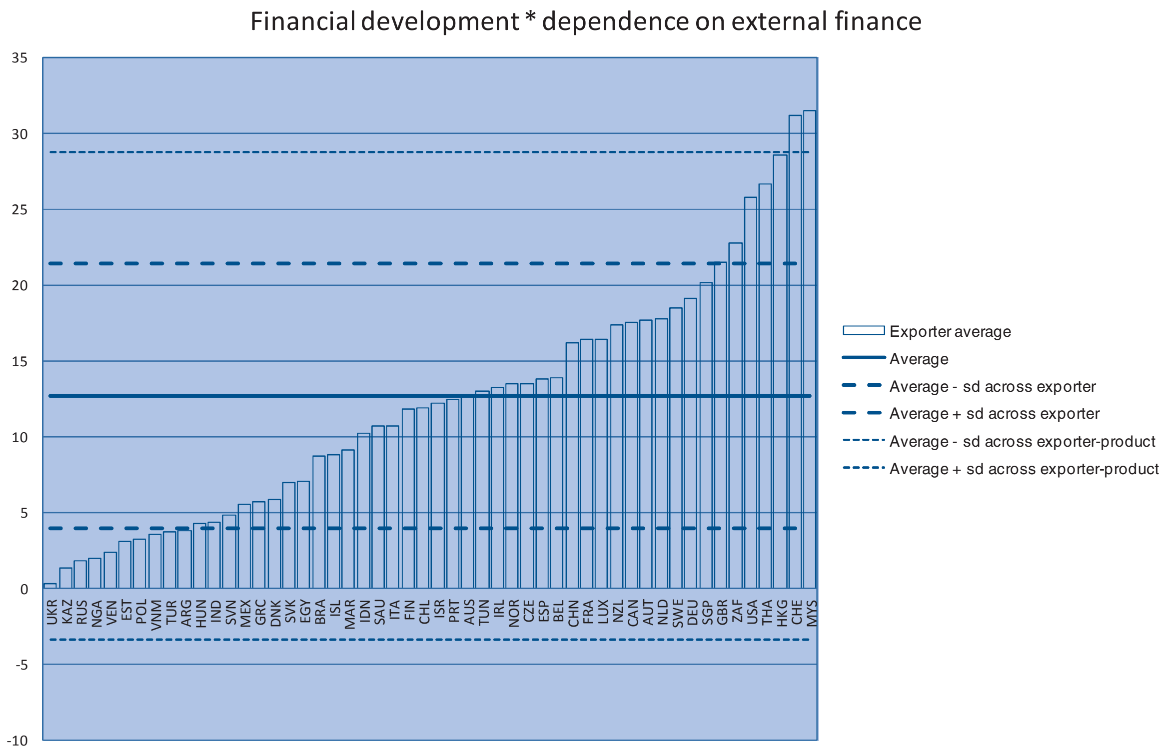
Log(energy supply) * energy intensity



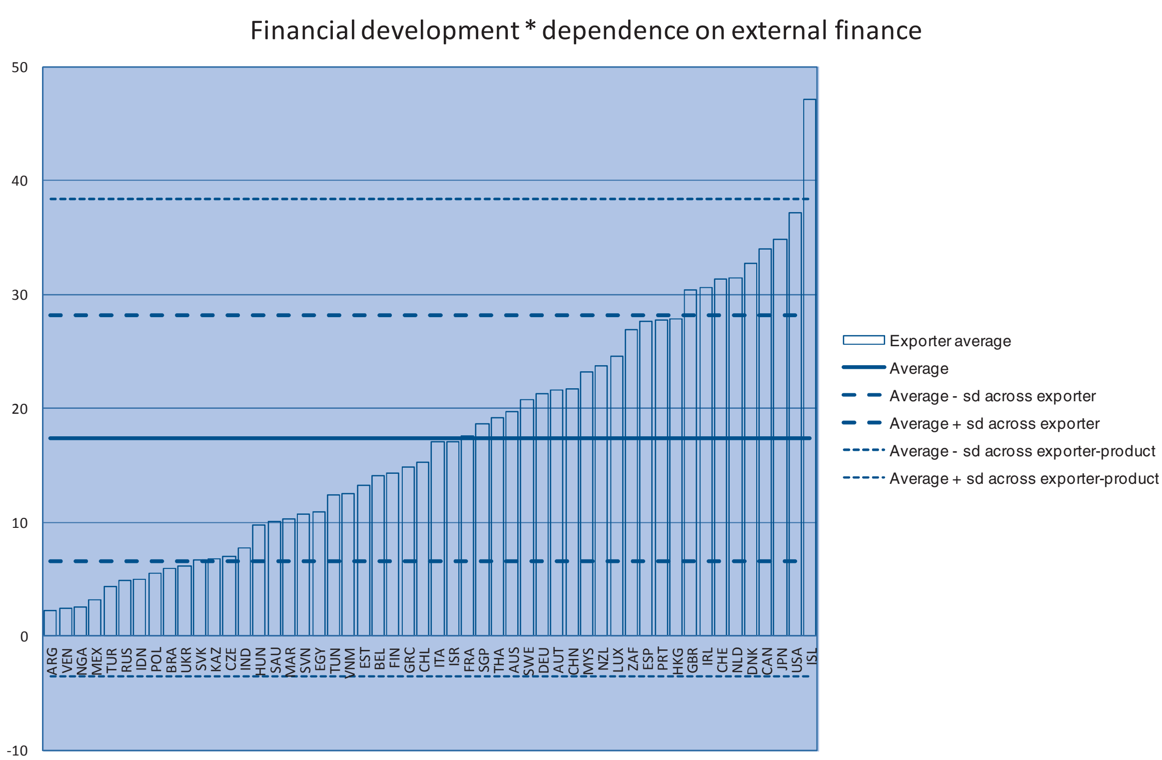
See variable definitions and sources in Annex 6.A.

Annex Figure 6.B5. Financial development and dependence on external finance: Variation across exporters and industries

1995



2005



See variable definitions and sources in Annex 6.A.

Chapter 7

The role of intermediate inputs and equipment imports in dynamic gains from trade

by

Susan F. Stone and Ben Shepherd[1]

This chapter examines the impact of the import of intermediate inputs and capital goods on firm-level productivity. It also systematically explores the specific impacts of non-trade, or complementary, policies on firms' ability to realise dynamic gains. Access to skilled labour is a particularly important policy variable with respect to the import of intermediate goods, followed by access to finance, while macroeconomic stability slightly outranks access to finance for capital goods importers. The importance of access to finance has particular policy significance given the wide-spread financial reforms being discussed or underway.

Traditional models of international trade, such as those based on Ricardo and Heckscher-Ohlin, focus on the gains in economic efficiency that result from specialization by comparative advantage. These gains are often referred to as the *static* gains from trade, in the sense that they are a one-off effect in improved efficiency brought about, for example by improved resource allocation linked to an increase in trade flows. More recently, attention has turned to the identification and quantification of dynamic gains from trade.[2] There are a number of avenues through which such dynamic gains can be realised, including: increased investment rates; technology transfer; spillovers from foreign direct investment; improvements in macroeconomic policies; or offshoring and internationalization of the supply chain.

Early attempts at understanding the dynamic gains from trade focused on identifying aggregate relationships through cross-country econometric analysis. For example, Sachs and Warner (1995) argued that economies with relatively open trade regimes tend to experience higher growth rates than those with relatively closed regimes. Harrison (1996) found a positive relationship between growth and a variety of trade openness measures.

Although intuitively appealing, methodologies applied to measure the relationship between increased trade and economic growth have been subject to extensive criticism (e.g. Rodriguez and Rodrik, 1999). Based on a comprehensive review of the evidence, Nordås *et al.* (2006) conclude that the most convincing examples from this openness and growth literature support the view that a 1% increase in trade openness, defined as an increased share of trade in GDP, can boost per capita GDP by around 1%-2%.

The more recent literature on the dynamic gains from trade takes a different approach rather than broad-based measures of GDP and economic openness (focusing on firm and sector dynamics). On the theory side, the heterogeneous firms models of Melitz (2003) and Chaney (2008) provide a rigorous basis for the existence of a link between trade liberalisation and within-sector productivity gains: as less productive firms exit the market due to stronger competition from imports, resources shift to more productive firms which can then produce and sell more. The net result is an increase in average sectoral productivity. The importance of this mechanism has been confirmed by a wide range of empirical studies using data from thousands of firms in developed and developing economies alike.[3]

This chapter expands the existing literature in several directions. First, using detailed micro-founded mechanisms rather than broad, cross-country macro-based correlations allows us to develop insights which will be more effective in addressing policy development. Because the relationships are examined at the firm and sector level, we gain a better understanding of the trade-growth relationship for a more focused policy analysis. Thus, this approach will help ensure that the results, and their policy implications, will be as robust and convincing as possible. Second, analysis on policy impacts that has been conducted in the literature has tended to focus on tariff and trade cost reduction. However, there is ample evidence that other policies, so-called complementary policies (Nordås *et al.* 2006), will also play a major role in an economy's ability to realize dynamic gains from trade. In this chapter we take the investigation beyond tariff policy and focus on measuring the impact of these complementary policies. We also expand the single-country framework of previous firm-level studies to include a number of developed and developing economies. Finally, given the relative scarcity of work on the dynamic gains from trade associated with particular types of imports, namely of intermediates and machinery, we examine these specific avenues of trade-related gains.

This chapter will proceed as follows. The first section will provide a brief literature review, including methodologies applied to examine dynamic gains; the next section will outline our approach, the data used and the expected outcomes, followed by the country-level and firm-level results. The final section will present conclusions.

What do we know about dynamic gains?

There is a large and varied economic literature that examines the links between trade and economic growth, i.e. the "dynamic gains from trade." They are dynamic in the sense that they relate to changing an economy's evolution through time. By contrast, the traditional "static" gains from specialisation by comparative advantage result in a one-off increase in welfare ascribed to a change in price resulting from, for instance, reduced costs from economies of scale or fewer market distortions, but do not necessarily alter the economy's growth path.

Over the last few years the academic literature has made a clean break with the macro-level "openness and growth" literature of the 1990s and early 2000s, to focus on detailed theoretical models with strong microeconomic foundations. This literature has provided a basis for linking trade and growth at the level of individual firms and sectors. In many cases, the main predictions of these models have been extensively tested using large, firm-level datasets from a variety of developing and developed countries. Firm-level empirics offer a number of methodological advantages over cross-country regressions, and for that reason have produced results that are now very broadly accepted in the economic literature. One advantage of firm-level data is the ability to control for country-specific factors that are not easily observed, such as the state of economic and social institutions, or the macroeconomic policy environment. Second, the richness of firm-level data allow researchers to test detailed hypotheses of individual mechanisms linking trade and growth; this approach contrasts with the openness and growth literature, which was sometimes criticized for treating the link between the two as a "black box". Third, focusing on individual countries and, in many cases, well defined episodes of trade liberalization, made it possible for researchers to observe how policy effects have differed in different environments. Results from these studies therefore tend to identify with relative precision the effect of a well-defined policy change on firms in a particular country.

The well-known model of Melitz (2003) shows that lower trade costs can promote the reallocation of resources toward more productive firms. As stated above, the expansion of these more productive firms causes relatively unproductive firms to contract or exit the market entirely, thus raising average sectoral productivity. The model provides micro-foundations for trade as a promoter of Schumpeterian "creative destruction". This model was extended by Melitz and Ottaviano (2008) to demonstrate that lower trade costs increase competitive pressures in the domestic market and lead to a fall in the mark-ups firms charge over marginal cost. Whereas the standard Melitz (2003) model relies on the reallocation of resources across firms within a sector, the Melitz and Ottaviano (2008) model emphasizes a process in which firms "trim the fat" in their operations: competition induces organizational change and production upgrading which ultimately boosts within-firm productivity. This process is often referred to as reducing so-called "x-inefficiencies."

There are numerous examples of firm-level evidence supporting these important processes. For example, Bernard *et al.* (2006) use data from US manufacturing firms to show that industries with relatively large falls in trade costs tend to experience larger increases in productivity. They find support for the intra-sectoral reallocation mechanisms and the reduction of x-inefficiencies. This process has been indentified in emerging economies as well. Muendler (2004) examines firm-level data in Brazil and finds that the most important productivity-enhancing mechanism is the within-firm reductions in x-inefficiencies. Pavcnik (2002) finds strong evidence that trade liberalization in the 1970s and 1980s in Chile led to significant productivity gains. Using firm-level data she finds support for the importance of within-firm and within-sector productivity gains. Iacovone (2009) examines the impact of NAFTA on Mexico and finds that on average a 1% reduction in tariffs led to productivity growth of 4% to 8%. The effect was much stronger for the most technologically advanced firms, with a 1% fall in tariffs associated with productivity gains of 11 to 13%.

The type of goods imported has also been shown to affect the level of productivity gains. Whereas consumer goods embody foreign technology but do not directly alter domestic production processes, foreign machinery and inputs act in the same way as a positive technology shock to domestic industry—manufacturing firms become more productive as they adopt more advanced production technologies. Finally there is also evidence that increased competition causes firms to be more innovative, increasing productivity and growth (see, for example, Teshima, 2008; and Sutton, 2007).

From this literature we see that one way in which imports can boost the productivity of domestic firms is through their role as a vector of technology transfer. Capital goods (machinery) and imported intermediates are particularly important in this regard. Eaton and Kortum (2001), for instance, find that innovation and capital goods exports are concentrated in a relatively small number of advanced countries. Their model suggests that up to 25% of observed productivity differences across countries is attributable to differences in the prices of capital goods. Around half of the price differences are due to trade barriers, suggesting that liberalization of trade in capital goods could provide a significant boost to productivity. Even more striking is the conclusion of Keller (2004), based on a comprehensive review of the theoretical and empirical evidence: foreign technology – embodied in imported inputs and capital goods – is the dominant source of domestic productivity growth, accounting for about 90% of the total. Recent empirical evidence from firm- and industry-level datasets reinforces the findings of Eaton and Kortum (2001) and Keller (2004).

While earlier work by Keller (2000, 2002) provides convincing evidence that foreign technology embodied in imported intermediate inputs plays a major role in spurring productivity growth (perhaps accounting for as much as 20% of observed productivity differences across OECD countries), Acharya and Keller (2007) broadly confirm these results. Miroudot *et al.* (2009) using trade data and national input-output tables for the period 1995-2005 show that for 29 industries in 11 OECD economies a higher proportion of foreign intermediate goods is associated with higher productivity. Part of this effect is due to more advanced technologies embodied in foreign inputs and part is due to reduced production inefficiencies as final good producers move closer to the technology frontier. Thus, all else equal, countries which allow firms access technologically advanced inputs, regardless of where they are produced, will be more productive than those that do not.

Goldberg *et al.* (2009) use a rich dataset of Indian manufacturing firms to examine this aspect of the dynamic gains from trade. A number of their findings confirm and reinforce those from the previous literature cited above. First, they find that India's trade liberalisation led to significant falls in the prices of existing imported intermediates; indeed, the effect was stronger than for final goods. Second, they find strong evidence linking tariff cuts in intermediate goods sectors with increased sales and higher productivity in final goods sectors.

Their most interesting findings, however, relate to the role played by new imported intermediates. Their data show that increased openness led to a significant expansion in the range of imported goods available in the Indian market, and that this effect was particularly strong in intermediate goods sectors. Moreover, they find that falls in input tariffs are associated with increases in firm product scope, i.e. the introduction of new final goods varieties. This finding is consistent with the mechanism discussed above, in which the introduction of new intermediate goods facilitates innovation in final goods markets. This effect is highly significant from an economic point of view: over the eight year period studied by the authors, firms increased their product scope by, on average, 25% and declines in input tariffs accounted for nearly one-third of that growth. Since increased product scope accounted for about 25% of total manufacturing growth over that period, the variety of intermediate inputs clearly represents an important source of dynamic gains.[4]

Although Goldberg *et al.* (2009) focus on variety growth in intermediate inputs sectors, their analysis could just as well be applied to capital goods sectors. As long as domestic machinery and imported machinery are imperfect substitutes, an expansion in the range of machinery imports should be associated with an increase in domestic innovation activity and, thus, with productivity gains.

While these studies provide overall evidence of the link between intermediate trade and productivity, they fail to provide the necessary detail to ascertain the relative importance of the different mechanisms through which this takes place. Nor do they explicitly consider the role non-trade specific policies can play in the process. To obtain a fuller understanding of the empirical importance, and particular policy-relevance of, different mechanisms through which open markets can generate dynamic gains, we examine the specific channels of intermediate and capital goods imports across a broad range of countries. We now look at what the relevant literature has to say about the role of policy.

The role of policy

Despite the important advances that have been made in the recent literature, it is nonetheless striking that the wider policy dimension has been relatively absent. The literature is primarily focused on the technical measurement of dynamic gains, and does not deal extensively with policy implications. However, a number of policy-relevant conclusions can be drawn from this previous work:

- Lowering trade costs can lead to domestic productivity gains at the firm- and sector-levels (e.g. Goldberg *et al.*, 2008).
- Intermediate inputs and capital goods sectors should receive particular policy attention in terms of reducing trade costs: the potential gains through domestic productivity improvements and innovation are probably greater than those from reducing trade costs in final goods markets (e.g. Amiti and Konings, 2007).[5]

While trade policy has been dealt with, at least on a limited basis, there is a second set of policy issues that has received little, if any, attention in the academic literature. We refer to these as "complementary policies," in the sense that these policies are separate from trade liberalization, but have the potential to significantly increase the benefits that flow from it. [6] As one example, Goldberg *et al.* (2008) conjecture that India's industrial policy may have inhibited the realization of gains from trade through rationalized within-firm product scope by reducing the incentive of firms to drop established, albeit unprofitable, product lines. Thus, reforms in industrial policy might be an important complement to trade liberalization. Since their analysis uses data for a single country, however, they are unable to test this possibility empirically, nor draw more generalisable conclusions.

In order to help fill this gap, we have identified three complementary policy areas that seem likely to play an important role in realising dynamic gains:

- *Barriers to entrepreneurship and competition policy*: Domestic firms' development of new products using foreign intermediate inputs or machinery is an important way in which trade liberalization can generate dynamic gains. Consequently, economies with barriers to the introduction of new products may have lower innovation rates and experience smaller dynamic gains from a given level of liberalization. Reducing barriers to entrepreneurship, such as the costs and complexity of obtaining licenses and permits, could be one way of making innovation easier, and thereby promoting larger dynamic gains from trade. Competition policy can also play an important role, since anti-competitive practices can discourage innovative firms from entering the market and developing new products.
- *Science, technology, education, and R&D policies*: The ability of domestic firms to take advantage of available new technology can also be crucial to the realization of dynamic gains from trade liberalization affecting markets for intermediates and machinery. Economies in which firms have a relatively high level of absorptive capacity can be expected to make fuller use of new technology — and thus experience stronger dynamic gains from trade — than those with a relatively low level of absorptive capacity. As a result, policies that promote technological capacity, such as support for education, training, basic science and R&D, can be expected to play an important role in helping maximize the dynamic gains from trade.
- *Factor market policies*: Regulation of labour and financial markets can also be expected to influence the extent to which an economy can realize dynamic gains from trade liberalization. For example, innovative firms need access to well-functioning financial markets in order to cover the costs of developing new products using foreign intermediates or machinery. They also need access to pools of skilled labour and technical expertise, which they can hire reasonably quickly and cost-effectively.

We explore the degree to which these mechanisms shape dynamic gains as this can have important implications for policy design.

Measuring the dynamic effects: Methodology and data

As stated above, to help further our understanding of trade's role in growth we are focusing on the role that imports of intermediate inputs and capital goods can play as a source of dynamic gains from trade. While we know that differing productivity levels play a role in trade (e.g. Trefler, 1993; and Davis and Weinstein, 2001), we want to examine the role trade in fact plays in productivity and growth. By interacting policy variables with the trade variables, we can also determine the extent to which policy influences and enables (or hinders) a country's ability to benefit from these potential gains.

This work examines the relationship between growth and productivity at the firm level. Pursuing this approach adds value by making the results more robust and thorough than results based on macro-level analysis or single-country studies. For instance, firm-level data can be highly effective in establishing relations that hold for a particular country, and can easily take account of unobservable and immeasurable country characteristics. However, generalization of these results can be problematic. By contrast, it is more challenging to control for unobserved country heterogeneity in a multi-country framework, yet covering a wide variety of countries lends weight to a claim that the results are of broad applicability.

Specifically, we address the question, on a firm-level basis for a variety of countries: what is the impact of imported intermediates and capital goods on productivity? We know that for individual countries examined, improved access to imported inputs raises productivity. However, we have not observed to what extent these results hold more broadly and outside a specific episode of trade liberalization or other specific trade-policy event. There are a number of theoretical papers which have emphasized the importance of intermediate inputs for productivity growth (e.g. Markusen, 1989; Romer, 1990; Grossman and Helpman, 1991) along with substantial empirical evidence that new product additions by firms account for a sizable share of sales growth in several countries. For example, Bernard, Redding and Schott (2010) find that large changes in firm scope (i.e. product adding and dropping) led to more efficient resource use and higher productivity while Goldberg *et al.* (2009) find that new imported intermediates, i.e. extensive margin growth, contributed significantly to manufacturing output growth in India. However, to go beyond the more general concept of extensive margins to examine the potential gains from imports of intermediates and machinery, we need to look at productivity at the firm level. We do this by measuring the impact of these imports on total factor productivity (TFP) of firms.

Finally, we know that innovation by firms promotes both productivity and growth. Therefore it is important to examine the extent to which growth in imported intermediates and capital goods promotes innovation at the firm level. Innovation is proxied using a measure of R&D spending by firms. This is consistent with other approaches used in the literature. For example, Sharma (2007), using a cross-section of 57 countries shows that financial market developments spur innovation in small firms using a measure of research and development (R&D) as an indication of innovation.

Data

Firm-level data on performance and the use of intermediate inputs and machinery are sourced from the World Bank's *Enterprise Surveys* dataset. That source currently has data on over 100 000 firms from 115 mostly developing and transition economies. As stated above, following Sharma (2007) we use R&D spending by firms as an indication of innovation. TFP is estimated from the survey data. The variety of imports is not available at the firm level, thus we rely on measures of import shares in total use of intermediates. The surveys report to what extent a firm relies on imports for its intermediate inputs and whether they import equipment. We also use the World Bank's *Enterprise Surveys* as a source of policy data for the firm-level regressions as detailed in Table 7.1.

Table 7.1. Complementary policies

Variable	Description	Time period	Source
Business obstacle	Dummy variable equal to unity if a firm indicates that the listed factor is a "major" of "very severe" obstacle to doing business	Various	Enterprise surveys
Capital goods importer	Dummy variable equal to unity for firms that 1) purchase equipment, and 2) import some or all of it	Various	Enterprise surveys
Employees	Total number of employees	Various	Enterprise surveys
Foreign	Dummy variable equal to unity for firms that are foreign owned	Various	Enterprise surveys
Imports/ total inputs	Percentage by value of intermediate inputs that are imported	Various	Enterprise surveys
TFP	Firm total factor productivity estimated using the Levinsohn-Petrin methodology	Various	Enterprise surveys

Regressions using firm-level data

The first stage in the analysis is to estimate productivity (TFP) for each firm. To do this, we use the methodology of Levinsohn and Petrin (2003) applied to each sector separately.[7] The output variable is total sales, deflated by the local GDP deflator and converted to US dollars at market rates. TFP levels are averaged for each firm over the (maximum three) periods for which data are available. The Levinsohn and Petrin (2003) approach enables us to control for unobserved productivity shocks using data on raw materials inputs. We prefer this methodology to Olley and Pakes (1996) because raw materials use is likely to be better measured than investment in the *Enterprise Surveys* data.

To examine the effects of imported intermediates and capital goods on the level of firm productivity, and on innovation (proxied by R&D expenditure), we use the following specifications:

$$log(tfp_{cif}) = d_{ci} + b_1 imports_{cif} + b_2 log(employees_{cif}) + b_3 foreign_{cif} + e_{cif} \quad (1)$$

$$\Pr(R\&D\ Spending_{cif}) = d_{ci} + b_1 imports_{cif} + b_2 log(employees_{cif}) + b_3 foreign_{cif} + b_4 products_{cif} + e_{cif} \quad (2)$$

where: c, i, and f index countries, industries, and firms respectively; *tfp* is our productivity index; *R&D Spending* is a dummy variable equal to unity if a firm engages in research and development spending; *imports* is sequentially the percentage of the total value of intermediate inputs that is accounted for by imports, and a dummy variable for firms that purchase capital goods from overseas;[8] *employees* is the total number of employees, as a proxy for firm size; and *foreign* is a dummy for firms that are foreign owned, and which are expected to be more productive than local establishments. Equation (1) is estimated by OLS, and equation (2) uses conditional fixed effects logit. We control for unobserved country-industry heterogeneity using fixed effects (d). Technology shocks specific to a particular sector-country pair are captured by this approach, as is the sector-specific impact of national macroeconomic fluctuations.

The role of complementary policies

We use interaction terms to investigate the role of complementary policies in facilitating dynamic gains from trade. As noted, we identify complementary policies using *Enterprise Surveys* data on business constraints. Firms are asked to indicate the extent to which particular factors—such as macroeconomic instability, barriers to entrepreneurship, access to finance and skills, and labour regulations—represent an obstacle to doing business. These factors are potentially relevant as complementary policies because they affect the ability of firms to: overcome human and financial constraints in accessing foreign inputs and capital goods; overcome constraints in using imported inputs and capital goods; introduce new and innovative products into the marketplace; and reorganize for maximum productivity following technological change.

We code dummy variables equal to unity if a firm identifies each factor as a "major" or "very severe" obstacle. Given this coding pattern, we expect negative coefficients on the interaction terms: for a given change in trade patterns, a less facilitating business climate should be associated with smaller dynamic gains because it inhibits firm growth and innovation. The equations we estimate take the following general form, where *obstacle* is defined as above, and all other variables are as in equations (1) and (2):

$$\log\left(tfp_{cif}\right) = d_{ci} + b_1 imports_{cif} + b_2 log\left(employees_{cif}\right) + b_3 foreign_{cif} + b_5 * imports_{cif} * obstacle_{cif} + e_{cif} \quad (3)$$

$$\Pr\left(R\&D\ Spending_{cif}\right) = d_{ci} + b_1 imports_{cif} + b_2 log\left(employees_{cif}\right) + b_3 foreign_{cif} + b_4 products_{cif} + b_5 * imports_{cif} * obstacle_{cif} + e_{cif} \quad (4)$$

Results

Applying the approach outlined above, we find strong support for dynamic gains at the firm level. In addition, investigations for various firm-level sector groupings show that these results are not uniform across sectors. We also find that the links among imported intermediate goods, productivity, and innovation appear to be stronger in non-OECD countries: they are thus particularly important from a development point of view.

Impact on productivity and innovation

As stated above, we utilise two measures to determine the impact of imports using the firm level data: TFP and R&D spending (to proxy innovation). Results for the basic specifications are in Table 7.2.[9] Using the share of imported inputs in total inputs we find a positive and significant effect on both TFP and innovation, providing robust evidence of dynamic gains at the firm level across a broad cross-section of economies.

For the level of TFP (columns 1 and 2), we find strong evidence of productivity effects from importing intermediates and capital goods: in both cases, the relevant coefficients are positive and 1% significant. These effects are quantitatively important: assuming constant returns, a firm that increases imports of its inputs by 1% increases TFP by around 0.3%; and a firm that increases it imported capital goods by 1% is around 0.2% more productive than one that increases from domestic sources only.

The smaller impact of capital goods imports on TFP could be due to several factors. One is the difference in the timing of effects. Intermediate inputs have a more immediate impact while gains from capital investment tend to be had in the longer term. Also, it is plausible that our data tend to over-sample foreign-owned firms engaged in assembly and re-exporting activities, which may not be in the best position to reap benefits from capital goods imports.

Table 7.2. Firm-level regression results: TFP and innovation *vs.* imports of intermediates and capital goods

DV	(1) TFP	(2) TFP	(3) R&D spending	(4) R&D spending
Imports / total inputs	0.298***		0.181**	
	(0.070)		(0.086)	
Capital goods Importer		0.167***		0.057
		(0.059)		(0.096)
Log(employees)	0.523***	0.380***	0.530***	0.384***
	(0.032)	(0.037)	(0.026)	(0.034)
Foreign	0.214***	0.308***	-0.018	-0.155
	(0.040)	(0.056)	(0.076)	(0.154)
N	7365	4352	14800	6997
Number of groups	230	122	406	161
R2 / *Pseudo-R2*	0.13	0.11	0.08	0.04
Fixed effects	Country-industry	Country-industry	Country-industry	Country-industry

Estimation is by OLS in columns 1-2 and by conditional fixed effects logit in columns 3-4. Robust standard errors (in parentheses) are adjusted for clustering by country-industry. * p<0.10; ** p<0.05; *** p<0.01.

Turning to the results for capital goods, we see that there is evidence, at the firm level, of a positive and significant impact on TFP. The result is positive but not significant on R&D spending. We hypothesize that being a foreign affiliate may account for the lack of a significant relationship between capital good importers R&D spending. Theoretical work by Rodriguez-Clare (1996) shows that foreign affiliates increase a host country's access to specialized varieties of intermediate inputs, and this access to improved knowledge raises the TFP of domestic producers as well. Empirical findings which validate this relationship can be found, for example, in Haskel *et al.* (2007) who report evidence for such a relationship for US manufacturing firms and Djankov and Hoekman (1999) who find that foreign investment has a positive impact on firm level TFP in the Czech Republic.

Including a variable for foreign affiliates has a positive and significant effect on the relationship with firm-level TFP, but not R&D spending.[10] The apparently limited role of capital goods imports at the firm level, on innovation (as measured by R&D spending) remains.

The lack of significance of capital goods imports on firm-level innovation may be due to the type of firms involved in both R&D and capital goods importing. Firms importing capital goods (whether they be foreign affiliates or domestic firms) are usually applying adapted technology to a manufacturing process. This implies that often the R&D expenditures are made elsewhere (in the case of foreign affiliates, the home country). While there is a trend toward the increasing internationalization of R&D activities, as of 2007, more than 78% of R&D spending still took place in OECD economies, 32% of that in the United States alone (UIS, 2010). This significant relationship between imported intermediates and R&D spending may be driven by the type of R&D spending, especially, if it differs in both substance and nature to that associated with capital goods.[11]

To investigate the general applicability of these results, we broke the sample into two groups: OECD and non-OECD. [12] Since the *Enterprise Surveys* data focus more on developing and transition economies than on OECD members, our OECD sample is necessarily small.[13] Indeed, there are insufficient data available to run regressions using capital equipment imports for OECD countries, and so we present split-sample results using imported intermediates data only. It is therefore important to be cautious in interpreting these results. Nonetheless, two aspects of our analysis suggest that the link between imported intermediates on the one hand, and productivity and innovation on the other, is particularly strong in non-OECD members. First, the coefficient on imported intermediates is noticeably larger in the non-OECD regression using TFP as the dependent variable (Table 7.3). In addition, only the non-OECD regression has a statistically significant coefficient on imported intermediates when we use R&D spending as the dependent variable. Both findings highlight the importance of imports of intermediate inputs regardless of the stage of development. However, the stronger results for developing countries show the major scope for leveraging imported intermediates as a source of productivity and innovation gains that can help drive the development process.

Table 7.3. Firm-level regression results for OECD vs. non-OECD countries: TFP and innovation vs. imports of intermediates and capital goods

DV	(1) TFP - OECD	(2) TFP – non-OECD	(3) R&D spending - OECD	(4) R&D spending – non-OECD
Imports / total inputs	0.213*	0.300***	0.112	0.208**
	(0.115)	(0.077)	(0.196)	(0.095)
Log (employees)	0.452***	0.545***	0.707***	0.472***
	(0.074)	(0.034)	(0.070)	(0.024)
Foreign	0.195	0.215***	0.043	-0.034
	(0.118)	(0.043)	(0.185)	(0.083)
N	1411	5954	2973	11827
Number of groups	33	197	103	303
R2 / *Pseudo-R2*	0.10	0.15	*0.17*	*0.06*
Fixed effects	Country-industry	Country-industry	Country-industry	Country-industry

Estimation is by OLS in columns 1-2 and by conditional fixed effects logit in columns 3-4. Robust standard errors (in parentheses) are adjusted for clustering by country-industry. * p<0.10; ** p<0.05; *** p<0.01.

To provide further detail on these results, we also run regressions separately for different sectors. To preserve an adequate number of data points for each regression, we group *Enterprise Surveys* industries into five sectors: textiles, leather, and garments; food and beverages; heavy manufacturing (metals and machinery, chemicals and pharmaceuticals, and automobiles); electronics; and light manufacturing (wood and furniture, non-metallic and plastic materials, paper, and other manufacturing). Table 7.4 shows that imported intermediates have a particularly strong impact on productivity in the light manufacturing and food/beverage sectors. There is also a discernable but weaker impact in electronics and heavy manufacturing. Imported capital goods, by contrast, have a strong impact on productivity in two sectors only: textiles, leather, and garments; and food/beverages (Table 7.5).

Table 7.4. Firm-level regression results by sector: TFP vs. imports of intermediates

Sector	(1) Textiles leather and garments	(2) Food and beverages	(3) Heavy manufacturing	(4) Electronics	(5) Light manufacturing
Imports / total inputs	0.098	0.566***	0.270***	0.241**	0.622***
	(0.079)	(0.124)	(0.069)	(0.063)	(0.148)
Log (employees)	0.426***	0.669***	0.289**	0.486***	0.622***
	(0.032)	(0.036)	(0.087)	(0.041)	(0.078)
Foreign	0.260***	0.321**	0.108	0.281**	0.168
	(0.051)	(0.097)	(0.063)	(0.074)	(0.108)
N	2214	1917	1235	246	1753
Number of groups	49	54	33	8	86
R2	0.312	0.203	0.028	0.615	0.112
Fixed effects	Country-industry	Country-industry	Country-industry	Country-industry	Country-industry

Estimation is by OLS. Robust standard errors (in parentheses) are adjusted for clustering by country-industry. * p<0.10; ** p<0.05; *** p<0.01.

Table 7.5. Firm-level regression results by sector: TFP vs. imports of capital goods

Sector	(1) Textiles leather and garments	(2) Food and beverages	(3) Heavy manufacturing	(4) Electronics	(5) Light manufacturing
Equipment importer	0.158**	0.303*	0.102	0.336	0.063
	(0.058)	(0.138)	(0.109)	(0.152)	(0.220)
Log (employees)	0.348***	0.635***	0.271**	0.417***	0.292***
	(0.035)	(0.063)	(0.093)	(0.048)	(0.073)
Foreign	0.243***	0.460	0.296*	0.453***	0.186
	(0.055)	(0.274)	(0.107)	(0.045)	(0.165)
N	1696	501	1053	607	495
Number of groups	38	17	24	8	35
R2	0.095	0.26	0.177	0.533	0.057
Fixed effects	Country-Industry	Country-industry	Country-industry	Country-industry	Country-industry

Estimation is by OLS. Robust standard errors (in parentheses) are adjusted for clustering by country-industry. * p<0.10; ** p<0.05; *** p<0.01.

We find that the imported intermediate share of total inputs has a positive and significant effect in all industry segments' TFP with the exception of the textiles grouping. It is likely this has more to do with the nature of the inputs to the textile sector than the quantity of those imported inputs. We know that the textile sector imports more intermediate inputs than, say, the food and beverages sector, yet the imported inputs share shows a relatively large (second only to light manufacturing) impact on TFP of food and beverage firms and not, as stated, on textiles. Thus, it is not just the volume of imported intermediates that is determining its impact on productivity but instead is more likely a function of the type of intermediate inputs that are imported. Much of the intermediate imports for the textile sector are raw materials which may not have the level of embedded technology as the imported intermediate inputs of other sectors do. In food and beverages, by contrast, products such as fertilizers and high-yield crop varieties can have a direct effect on productivity.

The especially strong results for light manufacturing may be explained by an economy's ability to adopt the imported technology, if we argue that the intermediate imports of the electronics sector require more skill in integrating than those in light manufacturing. We see a positive and significant coefficient for the electronics sector, but the size of the impact is smaller than for light manufacturing (1% increase in imported intermediates share leads to an increase of 0.62% in light manufacturing TFP versus 0.24% in electronics). We present evidence below that access to skilled labour influences a firm's ability to generate TFP gains. It could be that the type of intermediate inputs imported for light manufacturing are more easily adapted and dispersed through a greater number of entities than the technology embodied in electronics.

While imported intermediates shares are not significant in the textiles grouping, equipment imports are. This is in contrast to the other four sectors examined, each of which shows much stronger results for imported intermediate share. This implies that many textiles operations import more specialized (and thus not easily adapted and dispersed for wider gains) equipment to be used with domestically sourced (usually less-skilled) labour and may also further explain the lack of a relationship with TFP.

Tables 7.6 and 7.7 repeat the sector-specific regressions using innovation as the dependent variable. Again, results differ considerably across sectors. We find that imported intermediates have a particularly strong effect in the electronics sector, and discernable impacts in the food/beverage and light manufacturing sectors. These results are not dissimilar to those for productivity, reported above. In the case of innovation, however, we do not find any significant impact of equipment imports.

Table 7.6. Firm-level regression results by sector: Innovation *vs.* imports of intermediates

Sector	(1) Textiles leather and garments	(2) Food and beverages	(3) Heavy manufacturing	(4) Electronics	(5) Light manufacturing
Imports / total Inputs	-0.214*	0.496*	0.472**	0.727**	0.146
	(0.106)	(0.219)	(0.145)	(0.231)	(0.189)
Log (employees)	0.428***	0.530***	0.614***	0.476***	0.587***
	(0.036)	(0.055)	(0.054)	(0.139)	(0.051)
Foreign	-0.314*	0.237	-0.081	0.222	0.056
	(0.132)	(0.144)	(0.126)	(0.277)	(0.197)
N	4282	2934	4030	483	3071
Pseudo-R2	0.045	0.107	0.124	0.083	0.088
Fixed effects	Country-industry	Country-industry	Country-industry	Country-industry	Country-industry

Estimation is by conditional fixed effects logit. Robust standard errors (in parentheses) are adjusted for clustering by country-industry. * p<0.10; ** p<0.05; *** p<0.01.

Table 7.7. Firm-level regression results by sector: Innovation *vs.* imports of capital goods

Sector	(1) Textiles leather and garments	(2) Food and beverages	(3) Heavy manufacturing	(4) Electronics	(5) Light manufacturing
Equipment importer	0.060	0.170	0.109	0.036	0.026
	(0.166)	(0.160)	(0.223)	(0.303)	(0.196)
Log (employees)	0.246***	0.363**	0.510***	0.415***	0.485***
	(0.053)	(0.114)	(0.056)	(0.081)	(0.077)
Foreign	-0.201	0.696*	-0.059	-0.943***	0.105
	(0.182)	(0.281)	(0.174)	(0.155)	(0.225)
N	2361	986	1796	733	1121
Pseudo-R2	0.017	0.063	0.068	0.066	0.056
Fixed effects	Country-industry	Country-industry	Country-industry	Country-industry	Country-industry

Estimation is by conditional fixed effects logit. Robust standard errors (in parentheses) are adjusted for clustering by country-industry. * p<0.10; ** p<0.05; *** p<0.01.

Results including complementary policies

Table 7.8 presents selected outcomes from the regression analysis of the relationship between firm-level TFP and intermediate imports including interaction with a variety of complementary policies. We measure the influence of each policy variable (i.e. business obstacle) on the firm's ability to realize productivity gains through the share of imported intermediate inputs and capital goods. A significant interaction of the policy variables with the import measure suggests that policy plays an important role in the ability of a firm to gain from trade.

First we note that when the barriers to entrepreneurship, access to finance, access to skilled labour and labour market regulations are interacted with import shares, the effect on TFP is both negative and significant. We show that imports – both intermediate share and equipment imports – are associated with smaller productivity gains when the policy environment is viewed as restrictive. That is, the more firms identify regulation (labour market and licensing and permit procedures in particular) as a business constraint, the less is their ability to realize TFP gains through imports of intermediate goods and equipment. Creating a more facilitating business environment in any of these areas can increase an economy's ability to benefit from the dynamic gains from trade.

As hypothesized above, the results also show that access to resources plays a major role in realising dynamic gains. Having limited, or no, access to financing and to skilled labour impedes productivity gains available to firms through intermediate imports.

Turning to capital goods imports we see that macroeconomic stability and access to financing are major policy variables affecting these firms' ability to realise gains. This result is not surprising given that capital imports tend to be long-term investments sensitive to financing, including prevailing interest rates and longer term economic viability.

There are several policy implications from these results. First, the importance of a properly functioning financial market affects a firm's productivity through both intermediate imports and capital goods imports. It is, thus far, the only policy variable affecting both of the measured sources of dynamic gains from trade. This outcome is especially significant given the current debate on financial market reform. We show another avenue through which this reform impacts economic activity and further highlights the need for carefully crafted regulation.

Besides financial markets, an efficient labour market, supplying enough skilled labour, is also a notable policy variable. Investment in education continues to be a key for productivity growth in an economy. Finally, the importance of relatively short-term policy variables (such as barriers to entrepreneurship) versus the longer term environmental variables (such as macroeconomic stability) affect a firm's productivity through both its day-to-day activities (sourcing inputs) as well as its long term planning horizon (purchasing capital equipment). Undue attention to one set of variables risks forsaking sources of growth across the entire spectrum of potential dynamic gains from trade.

In general, we find extensive evidence that some sectors respond more strongly than others to particular changes in the policy environment. From a policy perspective, the most interesting result is that industries that are important from a development point of view – such as textiles, food and beverage, and light manufacturing – tend to respond to a range of complementary policies. Indeed, at least one of these crucial sectors responds significantly to each of the complementary policies we have data on. These results suggest that getting the right complementary policies in place should be a particular priority for developing countries.

Only one complementary policy produced significant results using innovation (the probability of R&D expenditure) as the dependent variable (Table 7.9). The interaction between imports of capital goods and barriers to entrepreneurship is negative and 1% significant. Governments can therefore facilitate innovation that relies on imported capital goods by lowering entry barriers in the domestic marketplace. This result suggests that R&D expenditure is more profitable in a low entry barrier environment – and thus more common – because firms can easily introduce new products into the marketplace. In environments where new products face substantial hurdles, the return to innovation is less, and it is harder for firms to make use of imported capital goods to innovate.

Table 7.8. Firm-level regression results for TFP vs. imports of intermediates and capital goods, including interaction terms with complementary policies

Policy variable: DV: TFP index	(1) Barriers to entrepre-neurship	(2) Access to finance	(3) Access to finance	(4) Labour regulations	(5) Macro-economic instability	(6) Access to skilled labour
Imports / total inputs	0.339***	0.380***		0.332***		0.346***
	(0.075)	(0.071)		(0.076)		(0.078)
Imports * business obstacle	-0.142*	-0.171**		-0.140*		-0.203**
	(0.081)	(0.084)		(0.076)		(0.080)
Capital goods importer			0.241***		0.238***	
			(0.075)		(0.072)	
Equipment * business obstacle			-0.169**		-0.189***	
			(0.068)		(0.067)	
Business obstacle	0.082*	0.036	-0.007	0.016	0.129***	0.071
	(0.044)	(0.036)	(0.029)	(0.038)	(0.039)	(0.045)
Log (employees)	0.525***	0.519***	0.378***	0.526***	0.379***	0.523***
	(0.032)	(0.031)	(0.037)	(0.032)	(0.036)	(0.031)
Foreign	0.209***	0.215***	0.307***	0.218***	0.307***	0.216***
	(0.042)	(0.042)	(0.058)	(0.042)	(0.056)	(0.042)
N	6963	7100	4319	6995	4290	7257
Number of groups	223	230	122	221	121	227
R2	0.13	0.13	0.11	0.13	0.12	0.13
Fixed effects	Country-industry	Country-industry	Country-industry	Country-industry	Country-industry	Country-industry

Estimation is by OLS. Robust standard errors (in parentheses) are adjusted for clustering by country-industry. * p<0.10; ** p<0.05; *** p<0.01.

Table 7.9. Firm-level regression results for innovation vs. imports of capital goods, including interaction terms with complementary policies

Policy variable: DV: Pr (R&D spending)	(1) Barriers to entrepreneurship
Capital goods importer	0.153*
	(0.090)
Equipment * business obstacle	-0.370**
	(0.153)
Business obstacle	0.336***
	(0.100)
Log (employees)	0.392***
	(0.032)
Foreign	-0.177
	(0.159)
N	6773
Pseudo-R2	0.05
Fixed effects	Country-industry

Estimation is by conditional fixed effects logit. Robust standard errors (in parentheses) are adjusted for clustering by country-industry. * p<0.10; ** p<0.05; *** p<0.01.

The sometimes unexpected role of policy is highlighted by the sector results presented below. As shown in Table 7.4, firm-level TFP was not significantly affected by equipment imports in heavy manufacturing and the effect was only just significant in the electronics sector. When the macro policy variable is included however, results for these sectors are positive and significant. Indeed, the interaction term shows that an unstable macro environment reduces equipment imports thus reducing potential TFP gains in these sectors. Textiles is the only sector with a significant relationship between R&D spending and the macroeconomic policy environment. The results also show a positive and significant relationship between R&D spending and foreign affiliates in this sector. This may indicate that a stable macroeconomic environment is more important for innovation among foreign firms than domestic.

As shown in Table 7.8, policies affecting resource markets are a key element in realising the dynamic gains from trade. This comes through again in Tables 7.10-7.16, where we present each complementary policy results at the industry level. For example, Table 7.16 shows that access to skilled labour is important to realising both sources of gains (TFP and innovation) in the electronics sector. Only the gains in the heavy manufacturing and textile sectors appear to be unaffected by the availability of skilled labour. There is indeed considerable variation across sectors in terms of the types of policies that are significantly associated with enhanced dynamic gains. We find that better competition policy is associated with stronger dynamic gains in the textiles sector (Table 7.10). Lowering the barriers to starting a business is associated with stronger dynamic gains in electronics, heavy manufacturing, and textiles (11). Access to finance is an important complementary policy in electronics, food and beverage, and textiles (Table 7.12). Labour regulations are associated with stronger dynamic gains in electronics and heavy and light manufacturing (Table 7.13). Better macroeconomic policies are associated with stronger dynamic gains in electronics, heavy and light manufacturing, and textiles (Table 7.14). Increasing policy certainty is an important complementary policy for electronics, food and beverage, and heavy industry (Table 7.15). Improving access to skilled labour can help boost the dynamic gains from trade in electronics, food and beverage, and light manufacturing (Table 7.16).

Table 7.10. Sector-specific firm-level regression results for innovation vs. imports of intermediate goods, including an interaction term with competition as a complementary policy

Sector: DV	(1) Textiles (Pr (R&D)
Imports / total inputs	-0.079 (0.141)
Imports * business obstacle	-0.453* (0.258)
Business obstacle	0.395*** (0.134)
Log (employees)	0.436*** (0.036)
Foreign	-0.314** (0.136)
N	3992
Pseudo-R2	0.049
Fixed effects	Country-industry

Estimation is by conditional fixed effects logit. Robust standard errors (in parentheses) are adjusted for clustering by country-industry. * p<0.10; ** p<0.05; *** p<0.01.

Table 7.11. Sector-specific firm-level regression results for TFP and innovation vs. imports of intermediate goods, including an interaction term with business permits as a complementary policy

	(1)	(2)	(3)	(4)	(5)
Sector:	**Electronics**	**Electronics**	**Heavy manufacturing**	**Heavy manufacturing**	**Textiles**
DV:	**TFP**	**Pr(R&D)**	**TFP**	**Pr(R&D)**	**Pr(R&D)**
Imports / total inputs	0.326***	0.686**	0.335***		
	(0.075)	(0.332)	(0.076)		
Imports * business obstacle	-0.212*	-0.871***	-0.303**		
	(0.110)	(0.287)	(0.131)		
Equipment importer				0.207	0.251**
				(0.246)	(0.111)
Equipment * business obstacle				-0.517**	-0.559**
				(0.248)	(0.259)
Business obstacle	0.241	1.311***	-0.061	0.107	0.512***
	(0.156)	(0.287)	(0.089)	(0.219)	(0.177)
Log (employees)	0.474***	0.547***	0.298***	0.520***	0.264***
	(0.052)	(0.099)	(0.088)	(0.057)	(0.046)
Foreign	0.356**	-0.133	0.105	-0.047	-0.256
	(0.109)	(0.225)	(0.062)	(0.175)	(0.195)
N	203	440	1196	1776	2238
R2 / *Pseudo-R2*	0.576	*0.112*	0.18	*0.072*	*0.025*
Fixed effects	Country-industry	Country-industry	Country-industry	Country-industry	Country-industry

Estimation in columns 1 and 3 is by OLS. Estimation in columns 2, 4, and 5 is by conditional fixed effects logit. Robust standard errors (in parentheses) are adjusted for clustering by country-industry. * p<0.10; ** p<0.05; *** p<0.01.

Table 7.12. Sector-specific firm-level regression results for TFP and innovation vs. imports of intermediate goods, including an interaction term with access to finance as a complementary policy

	(1)	(2)	(3)	(4)
Sector:	**Electronics**	**Food & beverage**	**Textiles**	**Textiles**
DV:	**TFP**	**TFP**	**TFP**	**Pr(R&D)**
Imports / total inputs	0.369***	0.686***	0.228**	
	(0.093)	(0.133)	(0.091)	
Imports * business obstacle	-0.403**	-0.307**	-0.221**	
	(0.147)	(0.135)	(0.105)	
Equipment importer				0.253
				(0.191)
Equipment * business obstacle				-0.374**
				(0.178)
Business obstacle	0.298*	-0.003	0.045	0.385***
	(0.149)	(0.050)	(0.062)	(0.131)
Log (employees)	0.486***	0.660***	0.422***	0.252***
	(0.039)	(0.035)	(0.032)	(0.053)
Foreign	0.353**	0.332***	0.243***	-0.173
	(0.111)	(0.100)	(0.054)	(0.191)
N	230	1866	2128	2344
R2 / *Pseudo-R2*	0.601	0.196	0.294	*0.02*
Fixed effects	Country-industry	Country-industry	Country-industry	Country-industry

Estimation in columns 1-3 is by OLS. Estimation in column 4 is by conditional fixed effects logit. Robust standard errors (in parentheses) are adjusted for clustering by country-industry. * p<0.10; ** p<0.05; *** p<0.01.

Table 7.13. Sector-specific firm-level regression results for TFP and innovation vs. imports of intermediate goods, including an interaction term with labour regulation as a complementary policy

	(1)	(2)	(3)
Sector:	**Electronics**	**Heavy manufacturing**	**Light manufacturing**
DV:	**TFP**	**TFP**	**TFP**
Imports / Total Inputs			0.708***
			(0.155)
Imports * business obstacle			-0.364**
			(0.173)
Equipment importer	0.480**	0.156	
	(0.138)	(0.120)	
Equipment * business obstacle	-0.345**	-0.333*	
	(0.118)	(0.187)	
Business obstacle	-0.030	-0.015	0.041
	(0.058)	(0.063)	(0.067)
Log(employees)	0.419***	0.272***	0.609***
	(0.050)	(0.092)	(0.078)
Foreign	0.469***	0.306***	0.170
	(0.036)	(0.105)	(0.108)
N	586	1033	1721
R2	0.528	0.186	0.111
Fixed effects	Country-industry	Country-industry	Country-industry

Estimation is by OLS. Robust standard errors (in parentheses) are adjusted for clustering by country-industry.* p<0.10; ** p<0.05; *** p<0.01.

Table 7.14. Sector-specific firm-level regression results for TFP and innovation vs. imports of intermediate goods, including an interaction term with macroeconomic policy as a complementary policy

	(1)	(2)	(3)	(4)
Sector:	Electronics	Heavy manufacturing	Light manufacturing	Textiles
DV:	TFP	TFP	TFP	Pr(R&D)
Imports / total inputs			0.800***	-0.005
			(0.154)	(0.168)
Imports * business obstacle			-0.346*	-0.480*
			(0.200)	(0.267)
Equipment importer	0.508**	0.249**		
	(0.167)	(0.106)		
Equipment * business obstacle	-0.428**	-0.328**		
	(0.146)	(0.137)		
Business obstacle	0.227***	0.169*	0.046	0.268**
	(0.064)	(0.098)	(0.089)	(0.111)
Log(employees)	0.414***	0.273***	0.617***	0.416***
	(0.046)	(0.089)	(0.077)	(0.035)
Foreign	0.449***	0.284**	0.176	-0.311**
	(0.035)	(0.108)	(0.107)	(0.134)
N	598	1041	1739	4199
R2 / *Pseudo-R2*	0.535	0.179	0.118	*0.044*
Fixed Effects	Country-industry	Country-industry	Country-industry	Country-industry

Estimation in columns 1-3 is by OLS. Estimation in column 4 is by conditional fixed effects logit. Robust standard errors (in parentheses) are adjusted for clustering by country-industry. * p<0.10; ** p<0.05; *** p<0.01.

Table 7.15. Sector-specific firm-level regression results for TFP and innovation vs. imports of intermediate goods, including an interaction term with policy uncertainty as a complementary policy

	(1)	(2)	(3)	(4)
Sector:	Electronics	Food & beverage	Food & beverage	Heavy manufacturing
DV:	TFP	TFP	Pr (R&D)	TFP
Imports / total inputs	0.279***	0.674***	0.779***	
	(0.064)	(0.153)	(0.203)	
Imports * business obstacle	-0.216**	-0.232*	-0.828**	
	(0.076)	(0.129)	(0.406)	
Equipment Importer				0.211**
				(0.080)
Equipment * business obstacle				-0.244*
				(0.140)
Business obstacle	0.314**	0.104**	0.254*	0.111
	(0.097)	(0.045)	(0.150)	(0.072)
Log (employees)	0.491***	0.660***	0.539***	0.276**
	(0.045)	(0.036)	(0.052)	(0.098)
Foreign	0.440***	0.406***	0.226	0.319***
	(0.080)	(0.068)	(0.143)	(0.111)
N	200	1809	2843	975
R2 / *Pseudo-R2*	0.662	0.194	*0.11*	0.186
Fixed effects	Country-industry	Country-industry	Country-industry	Country-industry

Estimation in columns 1, 2, and 4 is by OLS. Estimation in column 3 is by conditional fixed effects logit. Robust standard errors (in parentheses) are adjusted for clustering by country-industry. * p<0.10; ** p<0.05; *** p<0.01.

Table 7.16. Sector-specific firm-level regression results for TFP and innovation *vs.* imports of intermediate goods, including an interaction term with access to skilled labour as a complementary policy

	(1)	(2)	(3)	(4)	(5)
Sector:	Electronics	Electronics	Electronics	Food and beverage	Light Manufacturing
DV:	TFP	TFP	Pr(R&D)	TFP	Pr(R&D)
Imports / total inputs	0.249***			0.633***	
	(0.034)			(0.149)	
Imports * business obstacle	-0.428**			-0.503*	
	(0.179)			(0.287)	
Equipment importer		0.364*	0.177		0.256
		(0.160)	(0.288)		(0.206)
Equipment * business obstacle		-0.215**	-0.505***		-0.631*
		(0.087)	(0.180)		(0.326)
Business obstacle	0.216*	-0.091*	0.213***	0.078	0.536***
	(0.109)	(0.048)	(0.054)	(0.105)	(0.167)
Log (employees)	0.480***	0.418***	0.418***	0.665***	0.483***
	(0.043)	(0.050)	(0.084)	(0.034)	(0.080)
Foreign	0.356**	0.471***	-1.037***	0.349***	0.089
	(0.113)	(0.036)	(0.122)	(0.107)	(0.229)
N	228	599	725	1882	1117
R2 / *Pseudo-R2*	0.607	0.533	*0.072*	0.203	*0.064*
Fixed effects	Country-industry	Country-industry	Country-industry	Country-industry	Country-industry

Estimation in columns 1, 2, and 4 is by OLS. Estimation in columns 3 and 5 is by conditional fixed effects logit. Robust standard errors (in parentheses) are adjusted for clustering by country-industry. * p<0.10; ** p<0.05; *** p<0.01.

Conclusions

This chapter provides evidence of dynamic gains from trade through intermediate and capital goods imports, at the firm level. We show that the results are stronger for non-OECD economies, implying that imports can act as an important and positive boost to economic development. Further, we find that these gains can differ across sectors and that they are subject to the policy environment. The chapter provides insight into the types of policies that can be addressed to ensure these gains are realized and how these policies potentially interact in different industries. Thus, to further the outcomes of trade liberalisation in intermediates and capital goods, we present evidence that a wide range of complementary policies can help make the dynamic gains from trade even stronger. Examples include competition policy, lowering the entry barriers facing new firms, building human capital and improving access to skilled labour, improving access to factor markets (labour and capital), improving the macroeconomic environment, and reducing policy uncertainty.

A number of issues arose in the course of this work which deserve further attention. For example, what is the relationship between capital imports and innovation? We used R&D spending as a proxy for innovation, however, there may be other approaches which would provide better insight into this relationship. Also, we found that being a foreign affiliate was a significant determinant in the relationship between imports and firm level productivity but not innovation. Is this a function of the proxy, or is there simply no relationship? This information is of value to policy makers because the economic impact of foreign affiliates can be an important political issue. For instance is there a difference in the impact of investments made as part of a value chain, and hence meant for export, and those primarily serving the domestic market? Finally, given improvements in the data, expanding the number of sectors covered, as well as the country groupings beyond OECD and non-OECD, may provide further insights into the actual mechanisms of the productivity transfer.

Notes

1. Susan Stone, Senior Trade Policy Analyst, Trade and Agriculture Directorate, OECD, and Ben Shepherd, Developing Trade Consultants Ltd., New York, United States. Material presented in this chapter is based on the work declassified by the OECD Working Party of the Trade Committee as the *OECD Trade Policy Working Paper* No. 109 (Stone and Shepherd, 2011)

2. We use the term "dynamic" to refer to changes in productivity and economic growth that are brought about by trade. Differences in productivity account for the lion's share of cross-country differences in per capita income (Jones and Romer, 2009).

3. Bernard *et al*. (2007) provide a comprehensive review of the evidence. This literature includes evidence from accession and enhanced engagement economies: e.g. Brazil (Muendler, 2004); Chile (Pavcnik, 2002); and India (Topalova, 2004).

4. These findings contrast with those of Arkolakis *et al.* (2008) for Costa Rica. The likely reason, as Goldberg *et al*. (2009) point out, is probably that intermediate inputs are a relatively minor component of total imports in Costa Rica, whereas they play a much more significant role in India's overall import pattern.

5. This is not, of course, an argument for tariff escalation. It rather highlights the importance of including intermediate goods sectors within programs of broad-based trade liberalisation.

6. Complementary policies, as well as the relationship between trade and financial markets, represent the last two research areas identified by Nordås *et al*. (2006).

7. These estimation results are omitted in the interests of brevity. They are available on request.

8. In the equipment specifications, the sample is limited to only those firms that have purchased some equipment. The reason for this approach is to ensure that our results are capturing the differential impact of purchasing foreign, rather than domestic, equipment.

9. In additional results, available on request, we also interact the import variables with the foreign dummy variable, in order to examine the possible complementarities between trade and FDI. In the case of equipment imports, the interaction term is always statistically insignificant. However, the interaction term with intermediate inputs is negative and statistically significant for TFP and R&D spending. These results tend to suggest that foreign owned firms are less likely to engage in research activity for a given level of imports. One reason might be that the Enterprise Survey data perhaps over-sample foreign-owned firms engaged largely in assembly or re-export operations.

10. Due to limitations in the *Enterprise Surveys* data, it is not possible to code the foreign variable more finely to distinguish between, for example, foreign investment designed to serve the domestic market versus FDI aimed at exporting to nearby markets. The data only identify those firms that are foreign-owned.

11. For example, if inputs are imported to an established laboratory or research facility versus importing capital goods in an effort to establish such a facility. An investigation of the type of R&D spending by firm and import type is beyond the scope of this chapter.

12. We have also done separate regressions pooling across sectors but splitting the data by World Bank geographical region (results available on request). In most cases, the much smaller sample sizes involved fail to yield meaningful results. We find evidence of a significant link between imported intermediates or capital goods and TFP in East Asia and the Pacific, Eastern Europe and Central Asia, Latin America and the Caribbean, and South Asia. In addition, imported intermediates and capital goods both have significant effects on innovation behaviour in Latin America and the Caribbean, and that the former is also the case in the Middle East and North Africa.

13. The OECD sample includes only firms from the following countries: Chile, Czech Republic, Germany, Greece, Hungary, Ireland, Mexico, Poland, Portugal, Slovak Republic, Slovenia, Korea, Spain, and Turkey.

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Chapter 8

Determinants of diffusion and downstreaming of technology-intensive products in international trade

by
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The patterns of trade for a broad category of technology-intensive products, including advanced technology products (ATP), are analysed for a group of 15 economies in Asia, Europe, and the United States. This chapter finds that the degree of downstreaming is highly sector- and product-specific. For example, there has been more downstreaming of electronics than chemicals, of consumer electronics than electronic components, and of certain basic chemicals than specialized products, such as photographic film and cosmetics. The chapter also discusses the roles of technology, national and sectoral innovation systems, government policies, and other factors in shaping the degree of diffusion and downstreaming.

The production and export of certain goods normally considered to be "advanced technology" have shifted from higher-income to lower-income economies in recent years. In particular, China's pattern of exports has evolved rapidly, to converge toward that of high-income economies (Schott, 2008). China's trade with the United States in advanced technology products (ATPs), as defined by the US Census Bureau, shifted from deficit to surplus in approximately 2001 (Ferrantino *et al.*, 2009). However, many "high-tech" exports are also sourced from other low-income economies, particularly in Asia. Much of the attention has focused on electronics, with the export of personal computers and other consumer electronic goods from China being the most dramatic case.

It has been widely argued that these changes have important consequences for economic development. Some endogenous growth literature, and related empirical work, suggests that the "right" specialization permanently affects long-run growth (Lucas, 1988; Young, 1991; Grossman and Helpman, 1991; Hausmann *et al*., 2007), thus implying that "leapfrogging" strategies intended to move the geographical location of high-technology products to developing economies can enhance economic growth. If, as has been argued, the pattern of specialization in modern manufacturing is not closely tied to traditional sources of comparative advantage such as factor abundance, it is indeterminate and thus potentially easy to influence by policy (Rodrik, 2006). Some US observers have argued that China's policies have in fact led to a general leapfrogging in technology, and worried that this poses a major challenge to US commercial and security interests (Preeg, 2004; Choate and Miller, 2005).

This chapter argues that the recent experience of the electronics industry, and particularly of personal computers, does not generalize widely to other products that are technology-intensive and feature significant innovation. The more normal case is that it is difficult to move comparative advantage in innovative products, once it is achieved. Today's pattern of trade, at least in manufacturing, contains the fossilized economic history of yesterday's technology. It reveals a lot about which goods are hardest to produce, and a fair amount about where the hardest activities were done first, or best. The fossils may be obscured over time through patterns of erosion or catastrophe, each of which has its own economic logic. But it is the nature of catastrophes that they are unusual. While it is important to ask what may be special about China, or China's policies, it may be equally important to ask what is special about electronics in general, or about personal computers in particular.

We explore this idea using two trade-based indices of *revealed advanced technology products* (revealed ATP), one capturing diffusion (geographic de-concentration of exports) and the other capturing downstreaming (the movement of export activity to lower-income countries). These indices are both fairly simple, but they reveal a good deal of indirect information about the relative technological complexity of internationally traded goods, especially those involved in multistage production processes. This information can lead to a more focused inquiry about the relationships between technology, innovation, the international organisation of production, and international trade.

Background

The product cycle:[2] Concept and evidence

The idea that there is a logical progression under which newer, more innovative goods are produced in and exported from high-income economies, and later produced in and exported from lower-income economies, is of long standing (Vernon, 1966; see also Posner, 1961). In its most idealized form, a new good would be innovated and produced in the most advanced large economy (in the 1960s, the United States), because that economy had the most innovative capacity and because of "demand-push" innovation to satisfy the tastes of high-income consumers. The good would diffuse, eventually being produced in and exported from other economies than the original innovator. When the technology of production became sufficiently mature, the good would be produced in low-wage economies (in our terminology, downstreaming). This pattern was dubbed the "product cycle" by Raymond Vernon.

These informal theories developed at a time when there was not a lot of formal theory about the dynamics of comparative advantage, and when empirical work in international trade still faced challenges in testing the static implications of the Heckscher-Ohlin model. As it turned out, available tests of the product cycle have shown that it is not the typical pattern for all goods. In fact, patterns of long-run comparative advantage have shown a good deal of persistence, with only occasional downstreaming.

For example, Gagnon and Rose (1995) examine exports of six economies disaggregated to SITC4 from 1965 to 1989. They divide products into three categories — surplus, deficit, and balanced trade — using dividing lines at one standard deviation from the mean. Over their period, only about 1% of products switch between surplus and deficit, implying only a limited role for product cycles. Similarly, Proudman and Redding (2000) measure revealed comparative advantage (RCA) in a study of 22 broad ISIC-defined manufacturing sectors from 1970–74 to 1990–93. For France, Germany, the United Kingdom, and the United States, only a couple of categories switched from RCA 1 ≥ to RCA < 1 over the period in question. Japan, which was still experiencing convergence in per capita income during the period, was the most dynamic, losing RCA in rubber and plastic, textiles and clothing, and other manufacturing and gaining RCA in non-electrical machinery, electrical machinery, motor vehicles, and computers. Even for Japan, the other 15 industries did not change their status with respect to comparative advantage (see also Chapter 3).

It follows that an appropriate theory of the product cycle should account for the prevalence of such stickiness or persistence of comparative advantage in the usual case, and provide for some criterion for deciding when diffusion and downstreaming in the product cycle are actually being observed.

Predictions of trade theory about the product cycle[3]

In the traditional Heckscher-Ohlin model of international trade, the pattern of trade is determined by relative factor abundance. This implies that patterns of comparative advantage can shift over time only if relative factor abundance is evolving over time. An implication of this is that if some economies have faster-growing capital/labour ratios (or human capital/labour ratios) than others, the production and export of some capital-intensive or human-capital intensive goods will shift to these countries. Since there has been relatively rapid accumulation of physical and human capital in Asia, this by itself would account for product cycles in some goods. This prediction is robust to the addition of increasing returns and product differentiation, as in the first generation of Chamberlin-Heckscher-Ohlin models (Helpman, 1981; Helpman and Krugman, 1985), as long as scale economies are firm-specific and not nation-specific.

"New trade" theories with a focus on technology often predict that initial conditions drive the pattern of trade, leading to persistence in the pattern of comparative advantage over time. This persistence can come from a technological advantage that operates at the national level. For example, in the case of national, sector-specific economies of scale, if sectoral differences in scale economies outweigh sectoral differences in factor proportions, then the pattern of comparative advantage is determined by initial conditions (Kemp 1969; Markusen and Melvin, 1981). If nation-specific learning-by-doing in sectors is important, initial conditions also determine the pattern of trade (Lucas, 1988; Grossman and Helpman, 1991).

Such nation-specific, sector-specific technology economies can arise from regional agglomerations at the national or sub-national level (Marshall 1920; Krugman 1991). The characteristic features of a Marshallian industrial district or "Silicon Valley" include an abundance of specific skilled labour, which may move from firm to firm within the district; a similar localized abundance of producers of specialized capital goods and other inputs; and a general culture of knowledge exchange in which the secrets of a particular trade are, in Marshall's phrase, "in the air," and innovations are easily developed through a process of imitation, adaptation, and collaboration.

However, it is at least theoretically possible that certain kinds of knowledge may diffuse rapidly on a global level, leading to global scale economies (Ethier, 1979; 1982) or global knowledge spillovers (Grossman and Helpman, 1991). In the case of global technological dynamics, initial conditions do not matter for the pattern of trade, and one should expect relatively rapid product cycles.

In the actual history of technology and comparative advantage, there is not a single initial condition. Rather, there are initial conditions for new innovations at different times. The observed empirical pattern of regular persistence of comparative advantage, combined with occasional diffusion and downstreaming through product cycles, suggests that the extent of nation-specific as opposed to global economies related to technology is an empirical question. In this regard, Keller (2004) has demonstrated that trade-related knowledge spillovers are partly localized and fall with distance. Case studies of learning curves show that they are sometimes nation-specific, e.g. U.S. Navy ships in World War II (Searle, 1945), and sometimes more nearly global, e.g. light-water nuclear reactors (Cowan, 1990).

Synthesis

To summarize, there are three factors that tend to preserve historical patterns of comparative advantage in its initial or fossilized form:

- Relative factor abundance that changes slowly over time.
- Nation-specific economies of scale.
- Nation-specific learning-by-doing.

There are also at least three factors that tend to trigger product cycles (downstreaming and diffusion):

- Relative factor abundance that changes rapidly over time.
- Global economies of scale.
- Global learning-by-doing.

To these may be added two more:

- Foreign direct investment.
- Fragmentation or vertical disintegration of the production process.

These last two factors are interrelated. Vernon (1977) observed that the increasing prevalence of foreign direct investment meant that multinational firms were increasingly making strategic decisions about the location of production, thus possibly leading to an acceleration of the product cycle. The process of fragmentation or vertical disintegration by its nature alters the geography of production. A combination of a reduction in transport costs and economies of scale in executing individual stages of the production process means that it is possible to separate the various stages of production physically according to the comparative advantage associated with each stage. In the case of China, measures of the "vertical specialization" or "domestic content" of Chinese exports show that the share of imports in the value of Chinese exports is particularly high for electronics and other high-technology products (Dean *et al.*, 2007; Koopman *et al.,* 2008). This suggests that fragmentation is also an important driver of more rapid geographic product cycles.

Empirical strategy and data description

Our main empirical strategy is to derive measures of the product cycle at a high level of disaggregation over a recent period, employing a widely used index of concentration or diffusion (the Herfindahl-Hirschman index) and a second index of the level of relative income associated with revealed comparative advantage in the export of a particular good, to capture the concept of downstreaming. Measurement of diffusion and downstreaming correspond to the two phases of the traditional product cycle. Since the measurement of diffusion is also a measure of concentration, it can also be used as an indicator of Marshallian agglomeration economies that may inhibit downstreaming and lead to persistence in comparative advantage.

Main features of the dataset

Export data for 15 economies for the period 1997–2006 were obtained from the UN COMTRADE system maintained by the United Nations Statistical Division.[4] This ten-year period is shorter than those often used to test hypotheses relating to the product cycle, but long enough that disaggregated data can be used without product definitions changing too much.[5] Observations were taken on exports to the world, as reported by the exporting economy, of all Harmonized System (HS)-6 level subheadings, hereinafter "products." The selected products include all those in 21 HS-2 chapters selected from the 96 regular chapters, as listed in Table 8.A1 in the Annex. Broadly speaking, the product landscape consists of chemicals and allied products; machinery, electronics, and instruments; transportation equipment; and armaments. For comparability over time, the products are defined using the HS 1992 nomenclature. Products which for at least one year in the time period had no exports reported by any of the 15 economies are dropped.[6] In total, this yields 2 035 products.

The economies included in the dataset are listed in Table 8.2. They include the six largest Organisation for Economic Co-operation and Development (OECD) economies and nine Asian economies. Together, these 15 economies represent approximately 70% of world exports of the products in question, though the percentage varies from product to product. Where available, re-export data is subtracted from gross exports to yield net export data for the included economies and years.[7]

The HS-2 chapters are selected so as to include all products defined as ATPs by the US Census Bureau (hereafter "Census"), as well as chapters related to these chapters by type of product. Table 8.A3 presents the categories of ATP products, while Table 8.A4 provides a tabulation of the number of ATP products falling in each HS chapter. The ATP products, defined at the HTS-10 level,[8] are selected based on the expert judgment of Census staff regarding the technology intensity of products. The list of products used to construct China's *High and New Technology Product Import and Export Statistics Catalogue* corresponds closely to the Census ATP list.[9] Because the ATP list represents an independent judgment about technology intensity, it is a useful reference point to compare with inferences about technology intensity drawn from the trade data.

Construction of indices

Two indices are constructed for each product. In the following definitions, the index *i* represents a specific product (HS6 subheading), *j* refers to the economy exporting the product, and *t* represents the year. Letting x_{ijt} be the value of exports of good *i* from economy *j* in year *t*, the indices are defined as follows.

The first, HHI, is a Herfindahl-Hirschman index measuring the extent to which exports of a given product are concentrated among the economies in our sample. The HHI for each product *i* and year *t* pair is given by the following formula:

$$HHI_{it} = \sum_j s_{ijt}^2$$

where *j* is the index over economies and

$$s_{ijt} = \frac{x_{ijt}}{\sum_j x_{ijt}}$$

is the export market share of economy *j* in year *t*. Thus, an HHI value near 1 indicates that production of the product is concentrated entirely in one of our 15 economies, while low values (0.067 being the lower bound) indicate that exports are diffused throughout these economies.

The second index we construct, EXPRELY, is a GDP-normalized version of the index PRODY defined by Hausmann *et al.* (2007). EXPRELY is constructed as follows:

First, for each economy j in year t, the total exports[10] of economy j in that year are given by:

$$\bar{x}_{jt} = \sum_i x_{ijt}$$

Individual economy GDPs are per capita on a constant year 2000 dollar basis as taken from the *World Bank's World Development Indicators*.[11] Y_{jt} is then this GDP per capita value normalized by dividing by the US GDP per capita in the same year:[12]

$$Y_{jt} = \frac{GDP_{jt}}{GDP_{US,t}}$$

For each product i,

$$EXPRELY_{itT} = \sum_j \frac{x_{ijt}/\bar{x}_{jt}}{\sum_j x_{ijt}/\bar{x}_{jt}} * Y_{jT}$$

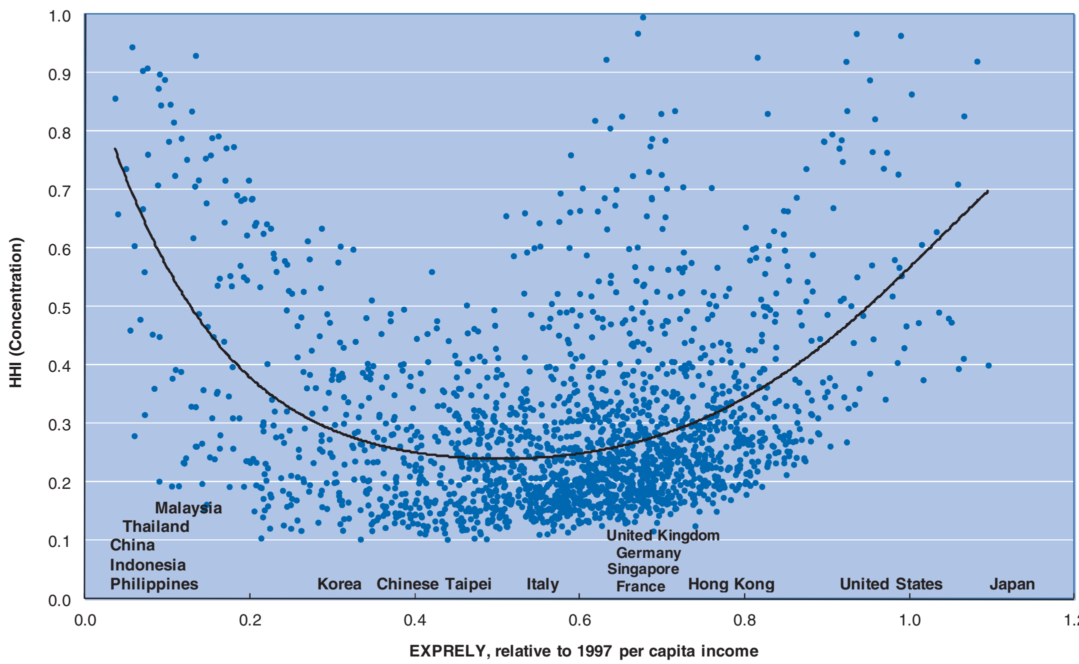
Thus, $EXPRELY_{itT}$ is a weighted average of the (normalized) year T GDPs of the economies exporting product i in year t, where the weights are the revealed comparative advantage of the economy. Rather than using GDP_{jt} in this expression, we compute EXPRELY in each year using only the GDP for each economy in a specified year T, in order to allow for cross-year comparison of the index. In particular, we fix the level of Y to its 1997 level in all years. Relative incomes change significantly over the period, particularly in the case of China, which experiences more rapid growth than average and which has a heavy weight in the calculations. For products whose exports become concentrated in China over time, if Y is allowed to vary by year, the calculated values of EXPRELY reflect both the movement to China (downstreaming of the product) and the relative position of China in the distribution of per capita income (upstreaming of China itself), making the results difficult to interpret. By fixing the level of per capita income to that of a particular year, we ensure that EXPRELY isolates the geographic movement of products "downstream," without conflating this effect with the general dynamics of development.

Stylized facts and anomalies

Relationship between diffusion and downstreaming in cross-sections and time series

Figure 8.1 presents a scatter plot of the relationship between HHI (diffusion) and EXPRELY (relative income level of economy with revealed comparative advantage) in 2006. For ease of interpretation, the names of the 15 economies are placed on the horizontal axis approximately at the level of their relative per capita income in 1997, as used to construct the index. A fifth-order polynomial is fitted to the data (Figure 8.1). The overall pattern is U-shaped. On the right, exports are concentrated in the highest-income economies, the United States and Japan. In the middle, exports are relatively diffused among all the economies, and associated on average with economies in the middle of the income distribution, e.g. Italy and Chinese Taipei. On the left, exports are concentrated in the lowest-income economies. While there are several of these, the left tail is accounted for primarily by concentration in China. For each of the 201 products with HHI > .25 and EXPRELY < .4 in 2006, China accounts for the largest market share. Of the outliers, some are clustered in upward-reaching "fingers" from the main U. These correspond to products that are concentrated in particular middle-income economies.

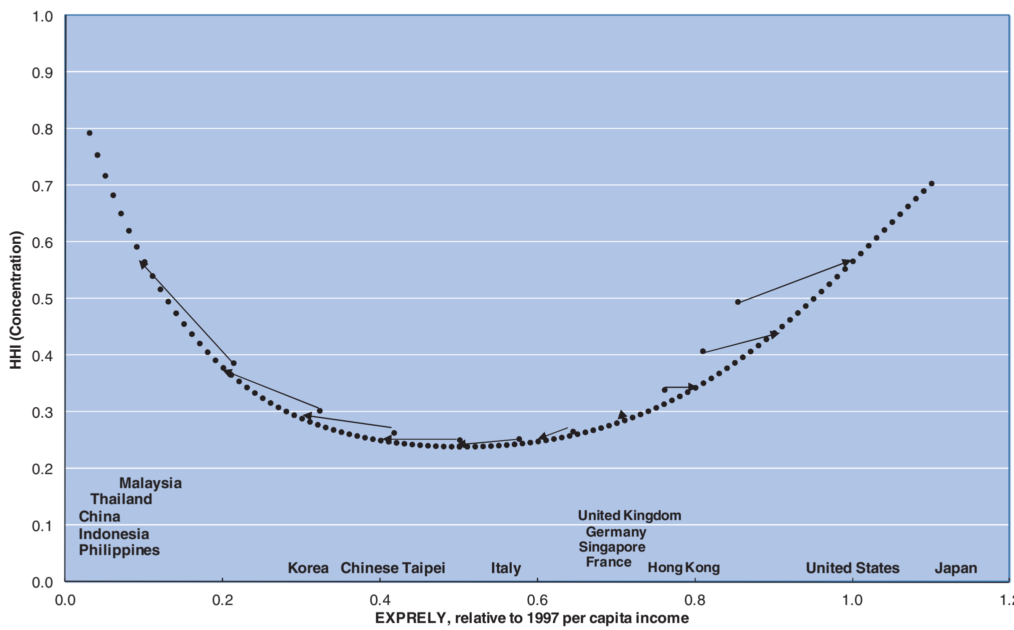
Figure 8.1. Scatter of HHI and EXPRELY, 2006



If taken from right to left, this pattern suggests something like the traditional Vernon product cycle (diffusion followed by downstreaming), followed by a final phase in which exporting is concentrated in China. This impression may be misleading, as figure 1 represents a cross-section and not a time series. Time-series behaviour may not be the same as cross-section behaviour.[13] Thus, we approximate the typical dynamic behaviour of HHI and EXPRELY between 1997 and 2006 using flexible second-order polynomial regressions with *dHHI* and *dEXPRELY* as the dependent variables (Figure 8.2 and Table 8.A13).

The resulting dynamics are superimposed over the stylized U in Figure 8.2. The results suggest on average that during the period in question, exports of many products became both more concentrated and more extreme in terms of the level of relative income they were associated with. Products that in 1997 were associated with a level of EXPRELY above .8 became more concentrated and moved upstream toward either the United States or Japan. Products associated with an upper-middle level of income (France, Germany, Hong Kong, Singapore, United Kingdom) remained about where they were. At somewhat lower incomes (Italy, Chinese Taipei) the typical product downstreamed but remained diffuse, while products associated with income levels equal to that of Korea or lower experienced both downstreaming and concentration (in China). While there are many special cases among the products in question, the overall pattern is one of agglomeration of exports in one of the three largest economies – China, Japan, or the United States – for the products in question.

Figure 8.2. Fitted relationship between HHI and EXPRELY in 2006, showing dynamics from 1997 to 2006



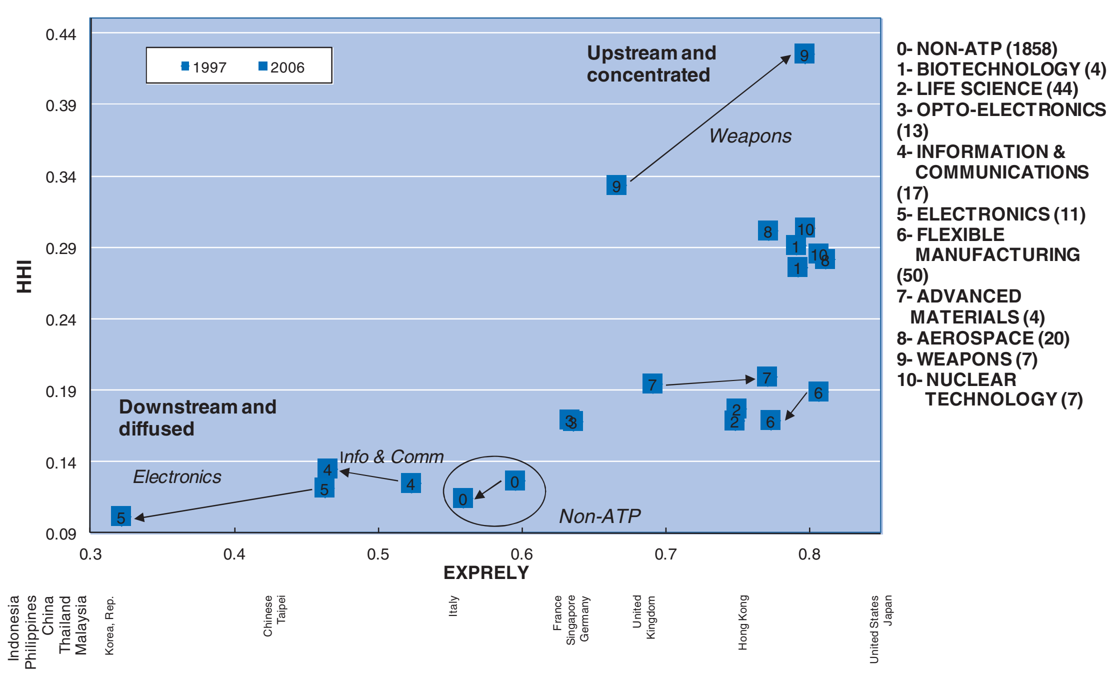
Sector-specific patterns

For the product landscape as a whole

Values of HHI and EXPRELY were calculated for both 1997 and 2006 for 11 aggregates of products: the ten ATP technology categories, which together account for 177 of the 2 035 products, and non-ATP products in the product landscape as a single group, accounting for the other 1 858 products. The results are portrayed in graphic form in Figure 8.3. The non-ATP products in the product landscape, represented by group 0, correspond approximately to the middle-level income of Italy, and they both diffused and downstreamed moderately during the period. Of the ten ATP categories, there is a marked difference between electronics and information and communications, and all the others. While eight of the ATP categories are both more concentrated and more upstream than the typical products in our landscape, two ATP categories – electronics and information and communications – begin in a position downstream from the average in 1997 and moved further downstream, with the decline in EXPRELY for electronics being especially rapid.

These results highlight the fact that electronics, and to a lesser extent information and communication, represent special cases. One would expect that more technology-intensive products would usually be produced in high-income economies, and that the advantages of agglomeration in fostering innovation would be similarly associated with many of these products. The complex knowledge necessary for innovative success in biotechnology, aerospace, weapons, and nuclear technology keeps these products upstream and concentrated. The largest group of ATP products, "flexible manufacturing," is relatively diffuse, but is still exported largely from high-income economies. This category includes advanced machine tools (including multiplanar and digitally controlled machine tools) used in many industries, and related instrumentation. The small category of "advanced materials," which has actually moved further upstream between 1997 and 2006, includes doped wafers for manufacture of semiconductors, and optical fibres and cables; both of these are essential components for many of the products in the two ATP sectors that are moving rapidly downstream.

Figure 8.3. Census' ATP products vary greatly in terms of diffusion and downstreaming



Machinery, computers, and instruments

We consider a broad subgroup labelled "machinery, computers, and instruments," which includes all products in HS chapters 84, 85, and 90. These amount to 905 products, or nearly half the total in our product landscape. Grouping them together like this enables us to consider computers, classified in HS 84, jointly with electronics in HS 85 and with many electronics-intensive products classified as instruments or measuring devices under HS 90. The grouping also includes a wide variety of capital equipment operating primarily on mechanical rather than electrical or electronic principles.

Table 8.A5 presents a cluster analysis of machinery, computers, and instruments based on the values of HHI and EXPRELY in 2006, reporting the within-cluster means. Consistent with our earlier results, the largest cluster, Cluster 1, contains products that are moderately diffused and relatively upstream. The second-largest cluster contains products which are

somewhat more diffused and further downstream. The third cluster contains 106 products which are both relatively concentrated (HHI = .331) and farthest downstream (EXPRELY = .243). Exports of most of these products are relatively concentrated in China. The smallest cluster contains 53 products which are both highly concentrated (HHI = .544) and, on average, further upstream than the other clusters (EXPRELY = .755).

Also reported is the percentage of products in each cluster categorized as Census ATPs. There is a broad correlation between the relative income level associated with a product and the likelihood that it is classified as an ATP on technological grounds. In Cluster 4, the furthest "upstream," 21.3% of products are ATP products. Moving downstream to Clusters 1, 2, and 3, the percentage declines to 17.1% in Cluster 1 (EXPRELY = .669), 12.3% in Cluster 2 (EXPRELY = .455), and 6.6% in Cluster 3. This suggests that the use of EXPRELY as a proxy for the technological sophistication of a product has some merit, at least for machinery, electronics, and instruments.

This also means that 41 of the 52 products in Cluster 4, or about 79%, were not classified by Census as ATP. It may be the case that the engineering concepts used by Census for categorizing goods as technology-intensive may not actually capture all of the characteristics of a product that make it difficult to produce or that prevent its technology from being cheaply or easily diffused. If our indices actually reveal something about the difficulty of technology, or the degree to which technologies experience localized economies of agglomeration, then there ought to be something "advanced" about these 41 products as well. Examples of such "revealed-ATP" products include outboard motors, cylinders for rolling machines, commercial dishwashing machines, ski lifts and chair lifts, bulldozer blades, milking machines and parts, brewery machinery, offset printing machinery, dobbies and jacquards for spinning machines and looms, dry-cleaning machines, pneumatic hand tool parts, electron beam machine tools, domestic kitchen waste disposers, and cameras for narrow-gauge film.

While the "upstream" location of some of these products may be explained in part by a trade between rich economies with similar patterns of demand, along the lines of the hypothesis of Linder (1961), they are likely enough to be technology-specific challenges associated with many of them. Moreover, similarity of rich-country demand must be coupled with at least some degree of technological sophistication to prevent easy downstreaming. For example, Christmas lights are exported from China, although their pattern of demand is presumably focused on high-income economies. It is likely harder to transfer the technology to produce outboard motors than that for Christmas lights.

It is also interesting to ask whether the ATP products in machinery, electronics, and instruments in Cluster 3 (downstreaming and concentration in China) have any particular characteristics. The seven products in question are listed in Table 8.A6. Of these, one is in a basket category that has recently been removed from the ATP list, and another (nuclear reactors) has some data difficulties. Of the remaining five, one has been well studied: HS 852190, labelled in 1992 as "video recording and reproduction apparatus, nes," is the category which now includes iPods and other MP3 players. The value chain of the iPod has been described by Linden *et al.* (2007). The iPod is a classic case of coordinated effort organized by a multinational firm (Apple, United States), managing a vertically disintegrated production process. Apple's gross margin makes up about one-quarter of the retail value of the iPod. Components of the iPod are produced in the United States, Japan, Korea, Chinese Taipei, and Singapore. Foreign companies also manage the China-based operations of hard drive manufacture (Toshiba, Japan) and insertion, test, and assembly (Inventec, Chinese Taipei). Moreover, although Linden *et al*. do not say so, the hard drive may have further imported components.

Of the others, the category labelled "cash registers" consists mainly of automated point-of-sale equipment such as toll collection devices. The three products in the category of transistors and semiconductors were until recently exported heavily by Japan or Singapore and have moved to the Philippines, suggesting perhaps another foreign direct investment story.

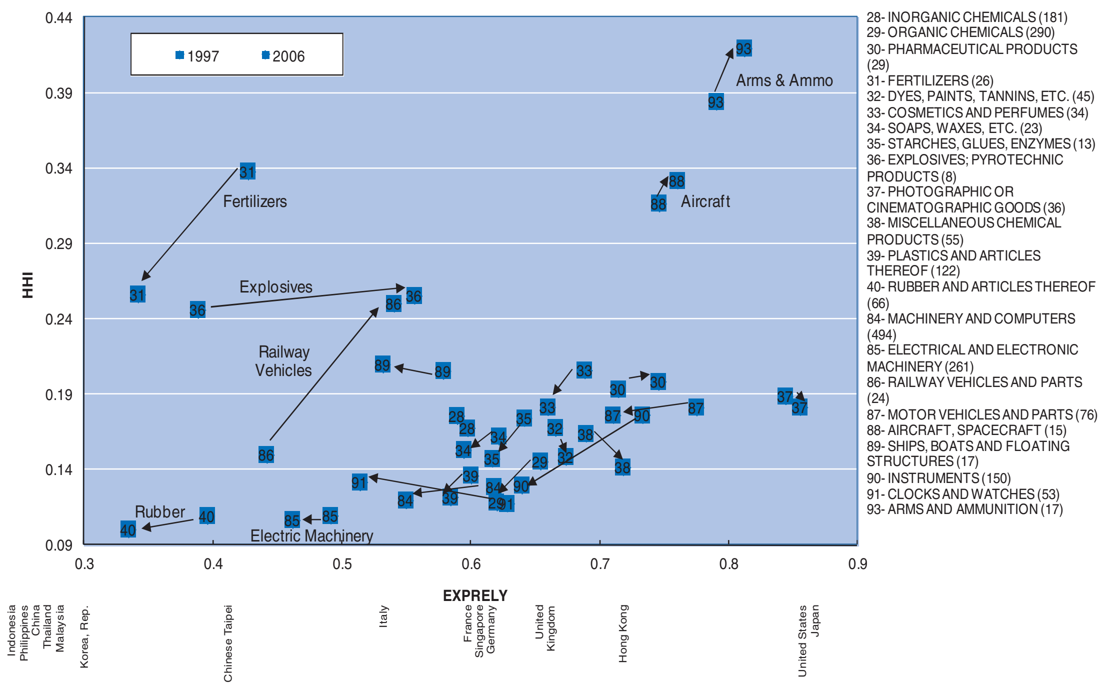
Machinery, electronics, and instruments which are both identified as ATP and appear in the upstream/concentrated cluster are identified in Table 8.A7. These include such products as numerically controlled metal drilling machines (Japan), stereoscopic and diffraction-apparatus microscopes (Germany and Japan), heart pacemakers (United States and France), certain other wood- and metal-working machines (Italy and Germany), small turbojet engines (United States), and theodolites and tachometers (Japan). It would be useful to be able to identify the technology features which tend to make them resistant to relocation in search of low-cost labour.

One can also group machinery, electronics, and instruments products in terms of the economies that dominate in their export. We identify groups of geographically focused products by clustering on 2006 market shares and identifying for each economy the cluster for which the market share is maximized. The results of this are presented in Table 8.A8. Of the six clusters, five are associated with a single dominant producer. The largest of these consists of products primarily specialized in by Germany, followed by China (with Thailand), Italy, Japan (with Hong Kong and Korea), and the United States. The role of Italy in exports of so many goods in this category may not be familiar. However, the emergence of Marshallian industrial districts fostering regional specialization in the so-called "Third Italy" during the 1960s and 1970s is well documented (Lazonick, 2005). The advantage of many of these districts is in a form of decentralized or "putting-out" manufacturing, as opposed to centralized mass production (Brusco, 1992). Italian specialties include machinery for leather-making, printing, food processing and agriculture, specialized wood and metal-making machinery, ski lifts, and sunglasses.

Organic chemicals and allied products

As a contrasting case, we consider a group of chemical products defined primarily by their relation to organic chemistry (HS 29, 30, 32–35, 37–40). Many of these products are chemical precursors (inputs) into other products in the category. This group of 713 products constitutes about 35% of the product landscape. In this section we present stylized facts, reserving a more detailed description of some of the technical features of these products until later. For the present, it is appropriate to note that organic chemistry as a whole is more technically challenging than inorganic chemistry.[14] Figure 8.4 reflects this fact in the position of chapter 28 (inorganic chemicals) relative to the various chapters involving organic chemistry mentioned above.

Figure 8.4. EXPRELY vs. HHI by HS2 chapter, 1997 and 2006, number of products included in category in parenthesis



A cluster analysis involving the organic-chemistry chapters is presented in Table 8.A9. Relative to each other, the four groups derived are similar to those presented in Table 8.A5 for machinery, electronics, and instruments. In an absolute sense, the ranges of both HHI and EXPRELY are noticeably higher for the organic-chemistry clusters than for the clusters in machinery, electronics, and instruments, suggesting that these products are on the whole more difficult to produce as well as more subject to specialization. (This can also be observed in Figure 8.4). Moreover, none of the 24 products in this group classified as ATP is primarily exported from the cluster furthest "downstream." This reinforces the view that the circumstances permitting the production and export of certain electronic products are special cases and do not in general apply to advanced chemical products.

The observation that exports of organic chemicals and allied products tend to cluster in a few high-income economies is further reinforced by the cluster analysis according to country market share presented in Table 8.A10. For comparison with Table 8.A8, we again use six clusters. The most notable difference is that while for machinery, electronics, and instruments, five of the six clusters were dominated by five different economies (Germany, Italy, China, Japan, and the United States); in the case of organic chemicals and allied products, five clusters are essentially dominated by four economies (China, Japan, the United States, and Germany, with a fifth cluster shared by Germany and the United States).

The German and US dominance is a reflection of long-standing historical patterns. Germany's advantage in advanced chemistry dates from the work of Justus von Liebig at the University of Giessen in the 1840s, and the subsequent close links between industrial innovation and university research developed at German firms such as BASF (Mokyr, 1990). Similarly, it was in the United States that the unifying principles involving scaling up of "unit operations" in experimental or batch production to a level providing workable and economic large-scale production processes were codified in the new discipline of chemical engineering, developed at MIT from 1915 to 1920 (Rosenberg, 1998).

Technological difficulty and the production chain

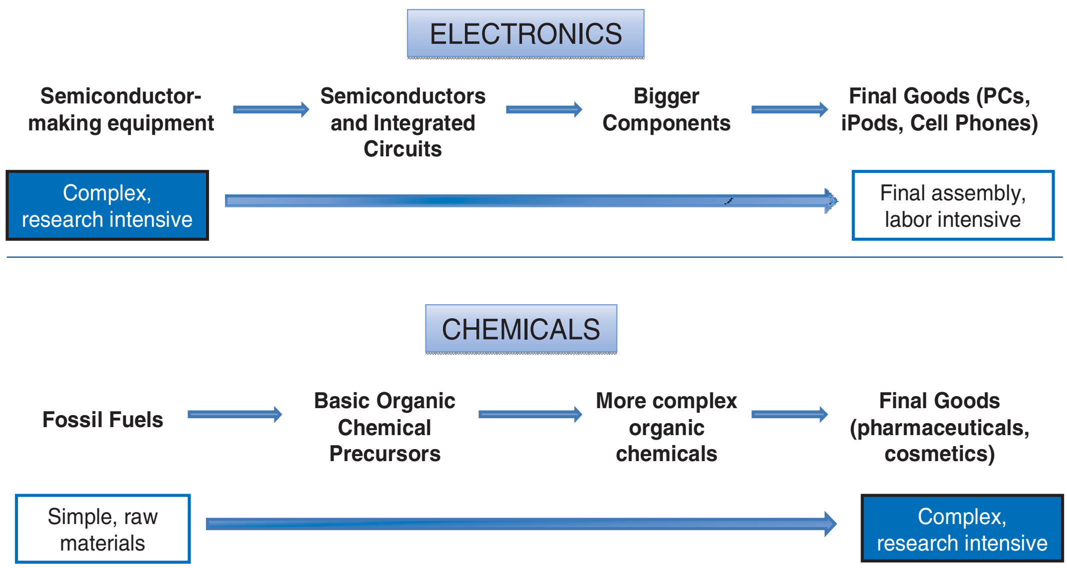
International trade takes place in intermediate goods as well as final goods. The combined forces of falling costs for logistics, strategic decision-making by multinational corporations, and international fragmentation of the production process have driven up trade in intermediate goods, as well as in the embodied services of product design and managerial coordination which are at the core of innovation. Merchandise trade data allow us to track the trade in goods. Are there systematic principles that allow us to relate the technological difficulty of earlier stages of the production process to the later ones?

In electronics, the earlier stages of the production process embody greater difficulty than the later ones. The inspection, testing, and final assembly of personal computers, cell phones, MP3 players, and other consumer electronic goods is a mature, labour-intensive process which easily gravitates toward low-wage locations. On the other hand, the production of semiconductors and integrated circuits is more difficult and must take place under carefully regulated conditions. Within the semiconductor industry, the most advanced products are designed by so-called "fabless" firms specializing in innovation and contracting production to "front-end" foundries. Front-end production in turn is more skill-intensive than "back-end" testing, assembly and packaging of semiconductors (Yinug, 2009). The technology involved in equipment and inputs for manufacturing semiconductors is sufficiently advanced that economies with a comparative advantage may seek to regulate exports of such equipment for strategic reasons (GAO, 2008).[15]

In organic chemistry, by contrast, the earlier stages of the production process involve refining relatively simple organic chemicals from mineral sources such as petroleum, natural gas, or coal, or, increasingly, from biological sources (e.g. ethanol). Basic chemical precursors are in turn synthesized into intermediate organic chemicals through a variety of chemical processes (e.g. polymerization for plastics). These are then used to make final chemical products. At each stage of the production process, the chemistry becomes more complex. The production of photographic film involves the careful combination of many organic chemicals in an emulsion. Exports of film (HS 37) are significantly upstream from exports of cameras (included in HS 90; see Figure 8.4 and Table 8.A15). Cosmetic and perfume products (HS 33) similarly involve difficult formulations of multiple compounds and mixtures of compounds. This can be confirmed by examining the list of ingredients in an inexpensive bottle of shampoo. As revealed by the income level associated with comparative advantage, cosmetics and perfumes are significantly more challenging to produce, or "upstream," than electrical and electronic goods (Figure 8.4 and Table 8.A15).

Thus, the relationship of the earlier or later stages of a vertical production process with the degree of technical complexity varies significantly depending on the nature of innovation in each product category. Figure 8.5 summarizes the stylized facts presented above. In electronics, the earlier stages of the production process are "high technology," whereas in chemistry, the later stages of the production process are more technology-intensive.[16]

Figure 8.5. Electronics vs. chemicals: Technological complexity in the production chain



To see whether the trade data reveal technological complexity, particularly by higher values of EXPRELY and (perhaps) by higher values of HHI, we constructed a number of subcategories of products. These include categories designed to correspond roughly to the stages of production portrayed in Figure 8.5, as well as other categories of interest.[17] We then recalculated the indices for products aggregated by subcategory. The results of this procedure appear in Table 8.A.11.

For petrochemicals and products, the first three categories correspond to the stages of production in Figures 8.5. In accordance with our hypothesis, we find that secondary petrochemicals are exported from higher-income economies than are basic petrochemicals, while products of petrochemical-consuming industries are exported from still higher-income economies. This progression is stronger in 2006 than in 1997. In 1997, but not in 2006, we find that the more advanced products are also more regionally agglomerated than the less advanced products. A fourth category of "plastic and rubber articles," including tubes, pipes, and other forms, involves the application of mechanical processes such as moulding to the results of chemical processes, and, not surprisingly, reverts to lower-income processes on average.

For pharmaceuticals, the detailed product descriptions in the HS enable a distinction between bulk medicaments (defined by chemical composition) and medicaments by dosage (made up in pill form). There is significant trade in bulk medicaments, which are made up closer to the market of final consumption (USITC, 1994). Both categories of pharmaceuticals are, on the whole, upstream and concentrated relative to the petrochemical categories.

Moreover, medicaments by dosage are upstream and concentrated relative to bulk medicaments. Like photographic film and cosmetics, medicaments by dosage often involve mixtures of two or more complex therapeutic compounds. The dosage requirements preferred by local medical practice are also reflected in the production of these goods, as well as features of the product such as texture or "mouth feel" important to the final consumer. It may also be the case that regulation for safety and efficacy is applied more stringently at the level close to the consumer.

The production chain for computers is reflected approximately in the first three categories under "electronics and related products." Here, the dramatic change is in the position of computers. In 1997, inputs to semiconductors (doped wafers and manufacturing machinery) are relatively upstream (EXPRELY = .750), as are computers (EXPRELY = .719), while semiconductors are exported from lower-middle-income economies (EXPRELY = .369).[18] By 2006, computers have "downstreamed" more dramatically than any of the other categories we analyze (EXPRELY = .250), while the positions of inputs to semiconductors and semiconductors/integrated circuits have remained relatively unchanged. This produces the pattern suggested in Figure 8.5, with inputs for semiconductors being the most advanced relative to computers. The position of other electronics-intensive products also indicated that EXPRELY is at least in part an indicator of technology intensity; electromedical devices are relatively upstream (EXPRELY = .692 in 2006, not much different than in 1997), while cameras (photographic and cinematographic apparatus) are even further downstream than computers and have moved there quickly in recent years (EXPRELY = .324 in 1997 and .140 in 2006).

Not only have electronic goods experienced an unusually intense product cycle relative to other goods, but computers have downstreamed very rapidly relative to other electronic goods. This applies to both desktop and notebook computers. After looking at all of the evidence, it appears less appropriate to view the shift of personal computers to China as paradigmatic of broader changes in the global economy, at least in the sense of geographic patterns of production,[19] and more appropriate to ask what is so special about personal computers.

Some suggestions as to the technological and managerial peculiarities of personal computers are offered by Dedrick and Kraemer (2009). The strong market positions of Intel in microprocessors and Microsoft in operating systems imply that those two firms may absorb as much as 90% of profits in the value chain for personal computers. This may have led to more intense searching for reductions in production costs elsewhere in the supply chain. Another feature of the development of the industry is the "middlement" role of original design manufacturers (ODMs) from Chinese Taipei, such as Quanta, Compal, Wistron, and Inventec. Such firms engaged in design and development of personal computers on behalf of US and Japanese multinationals such as Apple, Dell, HP, IBM, Sharp, Sony, and Toshiba, and accounted for 73% of the world's production of notebook computers by 2005. Production of such computers was increasingly outsourced to Chinese Taipei in the 1990s, with design activities following. After taking a leading role in design and development, the ODMs organized production activities in China from about 2000 onward, concentrating notebooks in Shanghai/Suzhou and desktops in Shenzhen/Guangdong, with other concentrations of production in Malaysia, Mexico, the Philippines, Singapore, and elsewhere. The geographical and cultural proximity of Chinese Taipei to Shanghai/Suzhou in particular meant that it was feasible for managers to move to the mainland for extensive stays to organize production networks.

The case of personal computers is an interesting example both of path dependency in the history of innovation and in the adaptation of organizational structure to the needs of the marketplace (Pavitt, 2005). Korean manufacturing firms, which are organized in large, interlocking families, are relatively good at achieving economies of mass production, and have played a significant role in the semiconductor industry, for example in following the mass production strategy of DRAMs (dynamic random access memories originally adopted by the Japanese). The supply of smaller, more agile entrepreneurial firms in Chinese Taipei was better suited for the elaborate systems coordination tasks required of ODMs. In an alternate history in which Korean firms succeeded in becoming the dominant players in personal computers in the mid-1990s, it may be wondered whether the further move to China would have been as rapid as it in fact was.

Machinery of the mechanical type is more difficult to categorize as being in the same category as either chemicals, where the final production steps are relatively technology-intensive, or electronics, where the first inputs are relatively technology-intensive. The HS contains a large number of "parts" categories that are explicitly mapped to the machines they are included in, and can thus be used to test the hypothesis of relative technology intensity of parts versus final product as revealed by trade. A partial and preliminary test of this hypothesis is presented in Table 8.A13, which considers approximately 40 categories of machinery, including agricultural, food-processing, print-making, and construction machinery, as well as engines, pumps, packing and weighing machinery. In general, no strong conclusions can be drawn about machinery. Parts tend, on average, to be produced in slightly higher-income economies than final machinery, and to be slightly less concentrated geographically, but there are plenty of special cases. This suggests that the relationship between the stage of production and the intensity of technology for machinery is very case-specific, as are the implications thereof for international trade.

Conclusions

The movement of production and exports of electronics (in general) and personal computers (in particular) to Asia (in general) and China (in particular) is sometimes held to be a sign of broad changes in the global economy and a wholesale reconfiguring of comparative advantage. We have shown that such widespread changes in comparative advantage are in fact less common than is often supposed. Many technology-intensive products continue to be exported primarily from high-income countries. In addition, many products not often thought of as embodying advanced technology are exported primarily from high-income countries, and are thus revealed to be technology-intensive by the data. The initial conditions under which innovation and production take place may become "fossilized" through patterns of local industrial agglomeration.

This does not mean that the technologies become stagnant. Rather, the advances in technology take place in a localized fashion. In addition to Silicon Valleys, there are likely to be many pharmaceutical valleys, cosmetics valleys, and valleys of pasta-making machinery. These are as important to the dynamics of comparative advantage as the processes by which electronics has undergone rapid downstreaming and diffusion. In particular, it appears to be harder in general for technologies related to organic chemistry to undergo rapid product cycles. This in turn has implications for a world in which biotechnology is likely to be the source of a significant share of new innovation.

The roles of foreign direct investment and production fragmentation in the product cycle are likely to be important as well, but we have not examined them directly. There are a number of cases in our data for which market shares have changed rapidly in the course of a year or two. We suspect that a significant share of these cases can be associated with specific acts of direct investment or contract production. Similarly, it should be possible to test directly the hypothesis that the product cycle is more rapid in industries prone to fragmentation and vertical disintegration.

The theoretical framework underlying predictions about the product cycle can certainly be used to interpret the Chinese experience, and perhaps the experience of other countries as well. China's rapid growth, beginning with its opening up of the late 1970s, has featured above-average accumulation of both physical and human capital by global standards. This type of growth, observed elsewhere in Asia, was a precondition for the attraction of certain kinds of goods and the movement of comparative advantage on Heckscher-Ohlin grounds. However, China's recent exports of ATP products have been associated with three types of policy initiatives: the encouragement of foreign direct investment, the encouragement of the processing trade (importing intermediate goods to use as inputs into exported goods), and the development of a variety of government policy zones associated with further incentives. Each of these policies is associated with a high share of ATP exports, both in general and relative to non-ATP exports (Ferrantino *et al.*, 2009).

In advance of the adoption of such policies, it would not have been possible to predict which goods would be subject to rapid product cycles. The industrial organisation of the personal computer and iPod, as they have developed, were not known in the early 1980s. However, any goods that did undergo diffusion and downstreaming would be more likely to be attracted to places that encouraged foreign direct investment, since multinationals play a key role in reorganizing the production process, and that would have encouraged processing trade, since this is attractive to goods with fragmented production processes. Thus, when the personal computer came, it would eventually come to China, as well as to other countries with similar patterns of factor accumulation that adopted policies designed to attract final assembly. China's size, along with the encouragement of regional agglomerations by policy, may also have led to nation-specific, sector-specific economies of scale and learning-by-doing, making it more likely that once having moved to China, the products would be likely to stay there.

In conclusion, although the dynamics described in this chapter apply to the current state of technology and international trade, we cannot say whether, and for how long, they will continue to do so. Massive changes in the technology and organisation of production – from the long-ago vertical disintegration of the pre-industrial putting-out system to the factory system of the Industrial Revolution to the return of vertical disintegration in our day, and from mass production driven by large-scale machinery to the dynamic of miniaturization associated with 20th century electronics – can happen suddenly and without warning at any time. Such changes in the future may lead to new patterns of international specialization very unlike those described here.

Notes

1. Lauren Deason, University of Maryland and the US International Trade Commission, and Michael J. Ferrantino, US International Trade Commission. Helpful discussions about technology with Renee Barry, Philip Stone, Stephen Wanser, and Falan Yinug are gratefully acknowledged, as well as the research assistance of Kyle Hutzler. Any errors or omissions are the sole responsibility of the authors. The views expressed are those of the authors alone and are not meant to represent the views the OECD or any of its members or of the US International Trade Commission or any of its Commissioners.

2. We use "product cycle" in the sense Vernon (1966) does, to refer to the geographic relocation of production and exports from one country to another, not in the alternate senses of the time it takes between the development of a new product and its marketing, or the time between generations of new products. Similarly, we use "downstream" ("upstream") to denote a geographical location of production in a low-income (high-income) location, and not in the alternate sense of a stage in a vertical production process closer to the final good (closer to the initial inputs). When we wish to refer to the stages in the production chain, we will do so explicitly.

3. Much of the argument in this section relies on the discussion in Brasili, Epifani, and Helg (1999).

4. This database can be accessed at *comtrade.un.org/db/*, accessed 17 August 2009. Data for Chinese Taipei were obtained separately from the version of COMTRADE available through the World Integrated Trade Solution (WITS).

5. We experimented with a longer dataset over the period 1962–2006, using the older SITC2 product categorization. At this level, products such as cellular phones and personal computers did not exist, and even mainframe computers are only imperfectly identified in the categorization.

6. This procedure resulted in the dropping of 22 products from the dataset. Additionally, products 846110, 392041, and 850890 were dropped due to an apparent data anomaly wherein several top exporters stopped reporting after 2001.

7. This results to an adjustment to the data for Hong Kong, the United States, and Thailand. The data for Singapore include re-exports. Thus, Singapore's exports are overstated relative to those of Hong Kong and include some double-counting.

8. Found at *www.census.gov/foreign-trade/reference/glossary/a/atp.html*, accessed 14 August 2009. The concordance based on 2006 US Import HTS10 nomenclature is used. Where products at the HS-6 level corresponded to multiple ATP categories, the ATP category with the most instances of that HS-6 subheading was assigned to the product.

9. See Ferrantino, Koopman, Wang, and Yinug (2009) for details.

10. Note that this is the total value of all exports for country *j* in year *t,* rather than the sum of exports of products included in our dataset.

11. WDI data are available at *www.worldbank.org/*. GDP data for Chinese Taipei are not available as part of the WDI data. Purchasing power parity GDP per capita data for Chinese Taipei are taken from the University of Pennsylvania's Penn World Table and converted to an exchange rate basis, using benchmark information.

12. Initially, this procedure was adopted to create an index that would be bounded above by 1. However, as later years were incorporated into the sample, Japan's GDP per capita rose above that of the United States, allowing EXPRELY to exceed 1 in some cases. The normalization still allows a useful comparison of the index for a given product to the index for a product exported exclusively by a country with the United States' GDP, which would have an EXPRELY value of 1. Normalized GDPs in benchmark years are given in Table 8.14. See Figure 8.4 for GDPs over the entire time span 1962–2006.

13. An analogous problem comes up in relation to the two famous "inverted U" relationships of development economics: the Kuznets curve relating per capita income to income inequality, and the environmental Kuznets curve relating per capita income to pollution.

14. Students who have taken a single chemistry course in high school or college in effect learn inorganic chemistry, because it involves simple molecules of a few atoms each whose equations can be easily worked out. Organic chemistry, involving more complex molecular structures, is generally only studied by students concentrating in chemistry, chemical engineering, or medicine. The basics of inorganic chemistry were reasonably well understood at the industrial level by the latter part of the 18th century (Mokyr 1990, pp. 107–109), and at the theoretical level by the time of John Dalton's New System of Chemical Philosophy in 1808. By comparison, significant industrial successes involving applications of organic chemistry were not achieved until the synthesis of artificial dyes in the 1850s and 1860s, with basic practices such as polymerization following in the 1920s and onward (Walsh 1984; Ruttan, 2001, pp. 286–315).

15. The point here is not to enter into the debate about whether such controls are effective in their objectives or appropriate on welfare grounds. The existence of the policy is simply put forth as evidence that the goods in question are recognized to represent technological "high ground."

16. See the figure in Ruttan (2001, p. 295) and the accompanying reference, for further discussion.

17. The definitions of these categories are available from the authors on request.

18. The downstreaming of semiconductors to markets such as Korea, Chinese Taipei, and Malaysia, for export in final assembly of computers in the United States, Japan, and Europe, was already well underway by the late 1980s and early 1990s. This history is recounted in Macher, Mowery, and Hodges (1998) and Langlois and Steinmueller (1999).

19. The fact that personal computers are themselves a general-purpose technology, responsible for increases in productivity and innovation in all industries, and that their production in China has made this technology more abundant and affordable worldwide, is of great significance.

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Annex 8.A. Tables

Table 8.A1. List of HS-2 chapters included in short-term dataset*

HS-2	Chapter description
28	Inorganic chemicals; organic or inorganic compounds of precious metals, of rare-earth metals, of radioactive elements or of isotopes
29	Organic chemicals
30	Pharmaceutical products
31	Fertilizers
32	Tanning or dyeing extracts; tannins and derivatives; dyes, pigments and other colouring matter; paints and varnishes; putty and other mastics; inks
33	Essential oils and resinoids; perfumery, cosmetic or toilet preparations
34	Soap, etc.; lubricating products; waxes, polishing or scouring products; candles etc., modelling pastes; dental waxes and dental plaster preparations
35	Albuminoidal substances; modified starches; glues; enzymes
36	Explosives; pyrotechnic products; matches; pyrophoric alloys; certain combustible preparations
37	Photographic or cinematographic goods
38	Miscellaneous chemical products
39	Plastics and articles thereof
40	Rubber and articles thereof
84	Nuclear reactors, boilers, machinery and mechanical appliances; parts thereof
85	Electrical machinery and equipment and parts thereof; sound recorders and reproducers, television recorders and reproducers, parts and accessories
86	Railway or tramway locomotives, rolling stock, track fixtures and fittings, and parts thereof; mechanical etc. traffic signal equipment of all kinds
87	Vehicles, other than railway or tramway rolling stock, and parts and accessories thereof
88	Aircraft, spacecraft, and parts thereof
89	Ships, boats and floating structures
90	Optical, photographic, cinematographic, measuring, checking, precision, medical or surgical instruments and apparatus; parts and accessories thereof
91	Clocks and watches and parts thereof
93	Arms and ammunition; parts and accessories thereof

*Chapter descriptions in this table are complete as taken from the US International Trade Commission website, *www.usitc.gov*. The following tables include abbreviated chapter descriptions for presentation purposes.

Table 8.A2. Economies included in the dataset

Abbreviation	Name
CHN	China
DEU	Germany
FRA	France
GBR	United Kingdom
HKG	Hong Kong
IDN	Indonesia
ITA	Italy
JPN	Japan
KOR	Korea
MYS	Malaysia
PHL	Philippines
SGP	Singapore
THA	Thailand
TWN	Chinese Taipei
USA	United States

Table 8.A3. ATP categories as defined by the US Census Bureau

ATP Category	Description
01	Biotechnology
02	Life science
03	Opto-electronics
04	Information and communications
05	Electronics
06	Flexible manufacturing
07	Advanced materials
08	Aerospace
09	Weapons
10	Nuclear technology

Annex Table 8.A4. Cross-tabulation of HS products in each included chapter falling into each ATP category

HS2 \ ATP	0 Non-ATP	1 Biotech	2 LifSci	3 OptoEl	4 InfoComm	5 Elec	6 FlexMan	7 AdvMat	8 Aero	9 Weap	10 NucTech	TOTAL
28	177	0	2	0	0	0	0	0	0	0	2	181
29	271	1	18	0	0	0	0	0	0	0	0	290
30	25	3	1	0	0	0	0	0	0	0	0	29
31	26	0	0	0	0	0	0	0	0	0	0	26
32	45	0	0	0	0	0	0	0	0	0	0	45
33	34	0	0	0	0	0	0	0	0	0	0	34
34	23	0	0	0	0	0	0	0	0	0	0	23
35	13	0	0	0	0	0	0	0	0	0	0	13
36	8	0	0	0	0	0	0	0	0	0	0	8
37	36	0	0	0	0	0	0	0	0	0	0	36
38	54	0	0	0	0	0	0	1	0	0	0	55
39	122	0	0	0	0	0	0	0	0	0	0	122
40	66	0	0	0	0	0	0	0	0	0	0	66
84	438	0	0	1	3	0	39	0	9	0	4	494
85	232	0	0	3	12	10	3	1	0	0	0	261
86	24	0	0	0	0	0	0	0	0	0	0	24
87	76	0	0	0	0	0	0	0	0	0	0	76
88	7	0	0	0	1	0	0	0	7	0	0	15
89	17	0	0	0	0	0	0	0	0	0	0	17
90	98	0	23	9	1	1	8	2	4	3	1	150
91	53	0	0	0	0	0	0	0	0	0	0	53
93	13	0	0	0	0	0	0	0	0	4	0	17
TOTAL	1 858	4	44	13	17	11	50	4	20	7	7	2 035

HS chapters containing products designated as ATP are highlighted.

Table 8.A5. Cluster analysis of machinery, electronics and instruments (HS 84, 85, and 90)

Clustering on Indices in 2006

Cluster	_FREQ_	HHI_06	EXPRELY_06	Description	Number of ATP products	% of products designated ATP
1	560	0.233	0.669	Low HHI, high EXPRELY	96	17.1%
2	187	0.199	0.455	Low HHI, moderate EXPRELY: diffuse	23	12.3%
3	106	0.331	0.243	Moderate HHI, low EXPRELY: downstreamed	7	6.6%
4	52	0.544	0.755	High HHI, high EXPRELY: high-tech	11	21.2%

Table 8.A6. ATP products in HS 84, HS 85, and HS 90 falling in Cluster 3 ("Downstreamed")

Product	Product_name	HHI_06	EXPRELY_06	Notes on market share (MS)
847050	Cash registers	0.181	0.341	Was dominated by Japan, China has taken over
840110	Nuclear reactors	0.352	0.159	Lumpy data
851999	Sound reproducing apparatus, non-recording, nes	0.717	0.169	Was dominated by Japan, China has taken over (no longer on ATP list)
852190	Video record/ reproduction apparatus not magnetic tape (includes iPODs and MP3 players)	0.537	0.160	Was dominated by Japan, China has taken over
854121	Transistors, except photosensitive, < 1 watt	0.162	0.147	Was dominated by Japan, Philippines has taken over
854129	Transistors, except photosensitive, > 1 watt	0.193	0.105	Was shared by Japan, Malaysia, Singapore, United States; Philippines has taken over (MS spiked in 2005: foreign direct investment?)
854150	Semiconductor devices, not light-sensitive or -emitting	0.194	0.113	Shared largely by Singapore and Philippines, Philippines has taken over

Annex Table 8.A7. ATP products in HS 84, HS 85 and HS 90 falling in Cluster 4 (“upstream”)

Product	Product_name	HHI_06	EXPRELY_06	HS2	ATP_Code	ATP_Category	Notes on market share (MS)
845910	Way-type unit head machines, metal working	0.601	0.587	84	6	Flexible manufacturing	Italy has highest MS over most of period
845921	Numerically controlled metal working drill machines	0.491	1.035	84	6	Flexible manufacturing	Japan dominates
846510	Multi-purpose machines for wood etc. work	0.542	0.637	84	6	Flexible manufacturing	Germany (followed by Italy, Untied States)
841111	Turbo-jet engines of a thrust < 25 KN	0.469	0.868	84	8	Aerospace	United States (Followed by Germany, Great Britain)
840120	Machinery & apparatus for isotopic separation & parts	0.685	0.687	84	10	Nuclear technology	Germany (followed by United States, Great Britain)
900661	Photographic discharge lamp flashlight apparatus	0.439	0.931	90	2	Life science	Japan (followed by China, Germany)
901210	Microscopes except optical, diffraction apparatus	0.405	0.985	90	2	Life science	Japan (followed by United States, Germany)
902150	Pacemakers for stimulating heart muscles	0.476	0.706	90	2	Life science	Untied States and France (followed by Germany)
901110	Stereoscopic microscopes	0.576	0.735	90	3	Opto-electronics	Germany (followed by Japan)
901520	Theodolites and tachometers	0.371	0.894	90	3	Opto-electronics	Japan
901720	Drawing, marking-out, instruments nes, slide rules	0.582	0.828	90	4	Information and communications	United States

Table 8.A8. Products in HS 84, HS 85 and HS 90 clustered by economy market share in 2006

Cluster	1	2	3	4	5	6
Number of products	217	94	113	364	75	42
GER_Market_Share	43.40%	17.80%	13.20%	15.80%	13.40%	8.20%
UK_Market_Share	5.10%	3.80%	4.50%	8.90%	3.90%	6.10%
FRA_Market_Share	5.40%	7.20%	3.90%	8.90%	5.00%	5.30%
ITA_Market_Share	9.20%	36.40%	4.80%	7.10%	6.00%	4.40%
HK_Market_Share	0.00%	0.10%	0.00%	0.10%	0.30%	0.20%
SNG_Market_Share	2.10%	1.50%	2.50%	5.10%	2.00%	4.60%
KOR_Market_Share	1.80%	2.80%	2.90%	4.00%	4.10%	0.50%
IDN_Market_Share	0.20%	0.40%	0.80%	1.50%	0.40%	0.30%
MYS_Market_Share	0.90%	1.20%	3.40%	3.70%	1.50%	0.70%
THA_Market_Share	0.40%	1.00%	2.50%	2.20%	0.90%	0.40%
PHL_Market_Share	0.10%	0.10%	0.30%	1.00%	0.20%	0.30%
USA_Market_Share	13.20%	10.30%	8.20%	18.90%	8.00%	56.20%
CHN_Market_Share	5.30%	8.50%	45.40%	9.00%	10.50%	6.70%
JPN_Market_Share	11.10%	5.00%	4.20%	9.40%	40.10%	5.30%
TWN_Market_Share	1.80%	3.90%	3.30%	4.30%	3.80%	0.80%
Number of ATP products	38	4	8	62	20	5
% of products classified as ATP	17.50%	4.30%	7.10%	17.00%	26.70%	11.90%

The shading in the table associates each cluster with a unique shading to the list of countries whose market share is maximized in that cluster.
The accompanying shading denotes the cell in which each country's market share is maximized across clusters.

Table 8.A9. Cluster analysis of organic chemicals and allied products (HS 29, 30, 32-35, 37-40)
Clustering on indices in 2006

Cluster	N	HHI_06	EXPRELY_06	Description	Number of ATP products	% of products classified as ATP
1	304	0.283	0.717	Low HHI, high EXPRELY: diffuse, mainly exported from high-income economies	16	5.3%
2	59	0.609	0.819	High HHI, high EXPRELY: "high tech"	1	1.7%
3	241	0.216	0.543	Low HHI, moderate EXPRELY: diffuse, exported from all economies	7	2.9%
4	109	0.370	0.254	Low/moderate HHI, low EXPRELY: "downstreamed"	0	0.0%

Table 8.A10. Organic chemicals and allied products clustered by economy market share in 2006

Cluster	1	2	3	4	5	6
Number of products	136	85	118	32	197	145
GER_Market_Share	11.40%	11.70%	6.90%	70.90%	33.50%	11.70%
UK_Market_Share	6.60%	4.00%	6.60%	1.80%	6.20%	15.60%
FRA_Market_Share	6.60%	4.60%	5.30%	2.20%	9.30%	12.30%
ITA_Market_Share	3.60%	3.50%	4.20%	3.00%	6.00%	11.00%
HK_Market_Share	0.10%	0.10%	0.20%	0.00%	0.20%	0.00%
SNG_Market_Share	2.40%	3.40%	4.20%	1.00%	2.40%	6.00%
KOR_Market_Share	2.50%	4.20%	2.70%	0.90%	2.80%	4.80%
IDN_Market_Share	1.60%	0.70%	0.60%	0.20%	0.90%	2.70%
MYS_Market_Share	0.70%	1.60%	0.90%	0.60%	1.50%	3.20%
THA_Market_Share	1.50%	1.10%	0.80%	0.30%	1.60%	3.80%
PHL_Market_Share	0.10%	0.10%	0.00%	0.00%	0.10%	0.20%
USA_Market_Share	9.50%	20.90%	50.90%	8.80%	20.00%	13.20%
CHN_Market_Share	45.20%	5.70%	7.90%	4.70%	6.00%	6.90%
JPN_Market_Share	6.10%	34.40%	5.70%	2.30%	6.30%	5.80%
TWN_Market_Share	2.00%	3.90%	3.10%	3.30%	3.10%	2.90%
Number of ATP products	5	2	2	0	6	9
% of Products which are ATP	3.70%	2.40%	1.70%	0.00%	3.00%	6.20%

The shading in the table associates each cluster with a unique shading to the list of countries whose market share is maximized in that cluster.

Table 8.A11. Indices by industry subgroups

	Relative income level		Concentration	
	EXPRELY		HHI	
Petrochemicals and products				
	1997	**2006**	**1997**	**2006**
Basic petrochemicals	0.556	0.479	0.135	0.128
Secondary petrochemicals	0.557	0.536	0.142	0.124
Petrochemical-consuming industries	0.641	0.601	0.152	0.130
Plastic and rubber articles	0.506	0.471	0.118	0.131
Bulk medicaments	0.582	0.661	0.148	0.176
Medicaments by dosage	0.665	0.691	0.207	0.200
Pharmaceuticals				
Bulk medicaments	0.582	0.661	0.148	0.176
Medicaments by dosage	0.665	0.691	0.207	0.200
Electronics and related products				
	1997	**2006**		
Photographic and cinematographic apparatus	0.324	0.140	0.126	0.127
Computer input, output, and data storage units	0.410	0.225	0.133	0.196
Computers	0.719	0.250	0.157	0.322
CRTs and other vacuum tubes	0.494	0.302	0.141	0.133
Radio, TV, and telecommunications equipment	0.347	0.338	0.099	0.208
Semiconductors and integrated circuits	0.369	0.357	0.118	0.114
Parts of radio, TV, and telecommunications equipment	0.523	0.419	0.112	0.168
Capacitors, resistors, printed circuits, and parts	0.463	0.432	0.128	0.139
Transmission equipment for radio, TV, telecom, and TV cameras	0.636	0.489	0.169	0.186
Electrical relays, switches, circuit breakers, etc.	0.642	0.559	0.161	0.139
Electro-medical devices	0.699	0.692	0.235	0.217
Doped wafers and machinery used in manufacturing semiconductors	0.750	0.753	0.221	0.194

Table 8.A12. Relationship between indices for machinery and parts in HS 8401-HS 8443

EXPRELY_06 (Parts) – EXPRELY_06 (Machines)

Range	Number of categories
Greater than 0.1	6
0 to 0.1	23
-0.1 to 0	11
Less than -0.1	5
Median	0.012

HHI_06 (Parts) – HHI_06 (Machines)

Range	Number of categories
Greater than 0.1	2
0 to 0.1	16
-0.1 to 0	20
Less than -0.1	6
Median	-0.004

Table 8.A13. Regressions used in Figures 8.1 and 8.2

dHHI = HHI_06 – HHI_97

dEXPRELY = EXPRELY_06 – EXPRELY_97

	HHI_2006	d EXPRELY	d HHI
Intercept	0.926 (0.065)	-0.204 (0.028)	-0.047 (0.023)
EXPRELY_06	-4.79 (0.028)	-0.079 (0.898)	-0.135 (0.063)
$EXPRELY\_06^2$	13.98 (4.25)	0.213 (0.065)	0.091 (0.054)
HHI_06		0.185 (0.079)	0.376 (0.065)
HHI_06^2		-0.067 (0.079)	0.107 (0.061)
EXPRELY_06* HHI_06		-0.047 (0.069)	0.150 (0.047)
$EXPRELY\_06^3$	-21.55 (8.96)		
$EXPRELY\_06^4$	17.23 (8.62)		
$EXPRELY\_06^5$	-5.21 (3.08)		
N	2035	2035	2035
R^2	0.247	0.184	0.282

Standard errors in parentheses.

Table 8.A14. Average HHI Values for HS Chapters, 1997–2006 (annual averages over ten years)

HS2	Chapter Description	Average HHI
93	Arms and ammunition; parts and accessories thereof	0.399
88	Aircraft, spacecraft, and parts thereof	0.330
31	fertilizers	0.291
36	Explosives; pyrotechnic products; matches; pyrophoric alloys; certain combustible preparations	0.264
86	Railway or tramway locomotives, rolling stock, track fixtures and fittings, and parts thereof; mechanical etc. traffic signal equipment of all kinds	0.212
89	Ships, boats and floating structures	0.208
33	Essential oils and resinoids; perfumery, cosmetic or toilet preparations	0.194
30	Pharmaceutical products	0.194
87	Vehicles, other than railway or tramway rolling stock, and parts and accessories thereof	0.183
37	Photographic or cinematographic goods	0.180
28	Inorganic chemicals; organic or inorganic compounds of precious metals, of rare-earth metals, of radioactive elements or of isotopes	0.167
90	Optical, photographic, cinematographic, measuring, checking, precision, medical or surgical instruments and apparatus; parts and accessories thereof	0.162
38	miscellaneous chemical products	0.156
34	Soap etc.; lubricating products; waxes, polishing or scouring products; candles etc., modelling pastes; dental waxes and dental plaster preparations	0.156
35	Albuminoidal substances; modified starches; glues; enzymes	0.156
32	Tanning or dyeing extracts; tannins and derivatives; dyes, pigments and other colouring matter; paints and varnishes; putty and other mastics; inks	0.154
29	Organic chemicals	0.131
39	Plastics and articles thereof	0.130
91	Clocks and watches and parts thereof	0.129
84	Nuclear reactors, boilers, machinery and mechanical appliances; parts thereof	0.119
40	Rubber and articles thereof	0.110
85	Electrical machinery and equipment and parts thereof; sound recorders and reproducers, television recorders and reproducers, parts and accessories	0.103

Table 8.A15. Average EXPRELY Values for HS Chapters, 1997–2006

(annual averages over ten years)

HS2	Chapter description	Average EXPRELY
37	Photographic or cinematographic goods	0.782
93	Arms and ammunition; parts and accessories thereof	0.750
88	Aircraft, spacecraft, and parts thereof	0.723
87	Vehicles, other than railway or tramway rolling stock, and parts and accessories thereof	0.694
30	Pharmaceutical products	0.685
90	Optical, photographic, cinematographic, measuring, checking, precision, medical or surgical instruments and apparatus; parts and accessories thereof	0.659
38	Miscellaneous chemical products	0.658
32	Tanning or dyeing extracts; tannins and derivatives; dyes, pigments and other colouring matter; paints and varnishes; putty and other mastics; inks	0.620
33	Essential oils and resinoids; perfumery, cosmetic or toilet preparations	0.617
29	Organic chemicals	0.586
35	Albuminoidal substances; modified starches; glues; enzymes	0.573
28	Inorganic chemicals; organic or inorganic compounds of precious metals, of rare-earth metals, of radioactive elements or of isotopes	0.552
34	Soap, etc.; lubricating products; waxes, polishing or scouring products; candles etc., modelling pastes; dental waxes and dental plaster preparations	0.551
39	Plastics and articles thereof	0.532
84	Nuclear reactors, boilers, machinery and mechanical appliances; parts thereof	0.517
89	Ships, boats and floating structures	0.515
91	Clocks and watches and parts thereof	0.497
86	Railway or tramway locomotives, rolling stock, track fixtures and fittings, and parts thereof; mechanical, etc. ,traffic signal equipment of all kinds	0.421
85	Electrical machinery and equipment and parts thereof; sound recorders and reproducers, television recorders and reproducers, parts and accessories	0.415
36	Explosives; pyrotechnic products; matches; pyrophoric alloys; certain combustible preparations	0.394
40	Rubber and articles thereof	0.347
31	Fertilizers	0.338

Chapter 9

Intellectual property reform and productivity enhancement

by
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For a broad sample of OECD countries, this chapter considers empirically the relationship between change in the protection of intellectual property rights (IPR) between 1990 and 2000 and the evolution of technological achievement, as well as the relationship of such achievement to change in labour productivity. The core assessment proceeds via regression analysis using a two stage approach and national level data. The results point to a positive and statistically significant relationship between indicators for protection of patent and trademark rights and technological achievement. The relationship between such technological achievement and labour productivity was positive and significant in certain specifications.

For a broad sample of OECD countries, this chapter considers empirically the relationship between change in the protection of intellectual property rights (IPR) between 1990 and 2000 and the evolution of technological achievement, as well as the relationship of such achievement to change in labour productivity. The motivation for this assessment draws on economic literature pointing to the potential influence of IPRs on the ability of innovators (and subsequent rights holders) to appropriate benefits from their innovations. This may affect economic incentives for the application of improved technologies in the economy (e.g. from domestic innovation and technology transfer from abroad, including via trade and foreign direct investment), with potential implications for productivity and, ultimately, comparative advantage. The core assessment proceeds via regression analysis using a two stage approach and national level data. The results point to a positive and statistically significant relationship between indicators for protection of patent and trademark rights and technological achievement (the coefficient for copyrights was not statistically significant). The relationship between such technological achievement and labour productivity was positive and significant in certain specifications.

This chapter is structured as follows. It begins with a statement on motivation and a brief review of the literature, followed by an overview of the analytical approach and data employed. The results are then presented. A short conclusion highlights implications of the findings and provides an indication of potentially fertile areas for further research.

Motivation

An appropriate degree of protection for IPRs can contribute to economic development and growth by helping to clarify ownership rights and by providing rights holders with a means to obtain benefits from their innovations; in turn, this establishes an incentive for innovation and diffusion of innovation (Maskus, 2000). Changes in IPR protection have been shown to be associated with change in indicators for innovation, technology transfer, trade and foreign direct investment (e.g. Park and Lippoldt, 2008; Cavazos *et al.*, 2010; Branstetter *et al.*, 2006). Such developments can facilitate the gradual accumulation of knowledge capital in firms, sectors and economies.[2] Thus, reform of inadequate IPR protection may be cited as one part of a general strategy for promoting economic development, in combination with other reforms (Park and Lippoldt, 2005).

The economic growth rates of open economies tend to be greater than those of closed economies (e.g. OECD, 2006). Market openness contributes to the realization of comparative advantage in a variety of ways such as through access to necessary technologies from abroad, availability of complementary intermediate inputs, and opportunities for specialisation and integration in international value chains. Internationally, these flow via international trade, foreign direct investment, licensing, and movement of personnel, among other channels. The degree of IPR protection available in a market can influence these international flows by providing rights holders with a means to appropriate the benefits of their innovations and to defend against abuse of their property (Maskus, 2000). The lack of adequate IPR protection in a country may in effect constitute a trade barrier in the sense that rights holders may be impeded in their ability to freely access the market to invest or trade their goods and services.

The international community has undertaken significant steps in the establishment of effective global minimum standards for protection of IPRs, particularly since the entry into force of the WTO Agreement on Trade-Related Aspects of Intellectual Property Rights (TRIPS) in 1995.[3] Nonetheless, IPR protection continues to vary significantly across countries, both due to flexibility permitted under the emerging IPR framework and shortfalls in the implementation of the system. Using the Patent Rights Index, Figure 9.A1 provides an illustration of the international strengthening of IPR protection and the remaining diversity in such protection (Park, 2008; Park and Lippoldt, 2008).[4] As can be seen, there has been a positive long-term evolution of the average index scores for developed and developing countries, as well as a persistent gap between the levels of protection for patent rights in these two groups of countries. Similar patterns can be observed for copyright and trademark protection (Park and Lippoldt, 2008).

The incentives related to IPR protection could have important effects on technological development, which in turn could influence productivity. As can be seen from growth theory, economic expansion depends on labour and capital inputs and the technologies employed to combine them into desired outputs (e.g. Solow, 1956). If the recent strengthening of IPR protection in fact provides better incentives for increased innovation and diffusion of innovation, this may promote increased accumulation and upgrading of technology. In turn, this may influence the productivity of labour by enabling more efficient processing of inputs in generation of desired outputs. Consequently, this chapter aims to examine the association of changes in the strength of IPR protection during the period from 1990 to 2000 with changes in technological achievement and the association of technological achievement with change in productivity. The objective is to consider the responsiveness of these dimensions of the economy to the improved incentives from strengthened IPR protection.

Literature review

This literature review briefly explores some of the key dimensions of a possible relationship of IPR protection to technology accumulation and productivity. The intention is to establish a foundation for the subsequent interpretation of the empirical analysis in the next section.

While Solow treated technology as an exogenous factor in his growth model, Romer (1986, 1990) developed a model with endogenous technological change, providing an early contribution to the literature directly exploring the role of technology in growth. Romer noted the non-rivalrous nature of technology, which means that technology may be used repeatedly and simultaneously without excluding others from additional use, providing a basis for increasing returns on investment. In such an environment, market incentives may fuel technological change, and diffusion and accumulation of technology.

Where an adequate degree of IPR protection is available, the incentives for innovation may be heightened compared to an environment where such protection is weak. IPR protection has an important economic function in helping to ensure clarity of ownership and enabling innovators and subsequent rights-holders to appropriate benefits from innovation (Demsetz, 1967). Once an appropriate degree of IPR protection is in place, there are several mechanisms through which protection of IPRs may influence the availability of technology from domestic and international sources.

IPR protection may stimulate domestic innovators to produce and diffuse innovation. For example, in a study covering developing countries during the period 1990 to 2005, Park and Lippoldt (2008) highlight the domestic innovative response that arose in association with strengthening of patent rights. In another example, Dutt and Sharma (2008) use panel data from 1989 to 2005 to determine whether enhanced IPR was a positive motivator for increased innovation by firms in India. They find strong evidence that Indian firms in innovation-intensive industries increased R&D spending after the TRIPS agreement in 1994. Indeed, the estimated increase in R&D spending by firms is 20% higher in industries that are one standard deviation above the mean in innovative intensity.

Internationally, IPR protection may contribute to an environment conducive to economically important technology transfer from abroad. Keller (2009) finds that in a majority of countries, foreign sources of technology are estimated to account for up to 90% of domestic productivity growth. Technical change on a global scale is therefore largely determined by international technology diffusion, which affects the distribution and growth of world incomes. Developing a better understanding of what causes technology diffusion can help to shed light on how economically lagging countries can catch-up.

The availability of technology is a key contributor to productivity, and differences in productivity are especially important in that they explain the large variation in incomes across countries (Hall and Jones, 1999; Keller, 2009). This matters in particular for the pace of economic development. For example, Comin and Hobijn (2010) argue that countries that performed well in the post-WWII period did so because they were able to adopt new technology quickly. In a further study, Comin and Mestieri (2010) found that 70% of differences in cross-country income per capita can be explained by differences in the speed of technology adoption.

Maskus (2004) points to five main market mediated channels for such technology transfer including trade, FDI (foreign direct investment), licensing, joint ventures and cross border movement of personnel. Park and Lippoldt (2005, 2008) have considered the first four of these channels and found a significant association of strengthened patent rights to these flows into developing countries. The association is particularly strong for FDI. With respect to other types of intellectual property, Park and Lippoldt also find significant but more modest relationships in certain cases with respect to copyright and trademark strengthening in developing countries.[5] Such technology transfer can facilitate the acquisition of technology directly by the parties concerned, while also helping to improve the absorptive capacity for new technologies more broadly (e.g. through human capital development[6]).

Measuring the impact of technology on economic growth, Eaton and Kortum (1995) isolate patterns of invention and technology diffusion from patent data and apply a model to explain productivity differences among OECD countries. They find that every OECD country except the United States derives more than half of its productivity growth from ideas from abroad. Finally, they conclude that a country's productivity level is largely determined by its ability to adopt new technology, regardless of whether that technology was developed at home or abroad. Schneider (2005) notes that high-technology imports are central to domestic innovation in both developed and developing countries, and foreign technology has a stronger impact on per capita GDP growth than domestic technology. One explanation is that imports provide innovations that do not exist in the local economy, and domestic researchers gain insights from these innovations. Based on this, by gaining access to foreign innovations, trade can be seen as facilitating technological diffusion and economic growth.

Openness and the ability to access technology appear to play an important economic role at the firm level. Firms now rely in part on external technology to enhance efficiency and productivity in order to adapt to new developments and stay competitive in the highly integrated global economy. This may be due to the heightened pace of innovation, the spread of production networks, and the need for interactive functionality of products, among other possible causes. For example, in a study of German manufacturing firms, Gantumur and Stephan (2010) find that those that acquired external technology experienced more productivity growth than non acquiring firms. The study also highlights evidence of complementarity between internal and external R&D (research and development) in innovation and production, and stresses that in the case of German manufacturing, firm size has been an important determinant of innovative efficiency and productivity of external technology acquirers.

Some early references on the role of IPR in development focus on the technological differences between the North (developed countries) and the South (developing countries) and the impact of enhanced IPR protection on welfare in the North and South. Chin and Grossman (1988), for example, consider a recurring tension between the North and the South over IPR, whereby the North bears the costs of innovation, and the South adopts low levels of IPR protection in order to benefit from the innovation of the North. However, Diwan and Rodrik (1991) provide a contrasting view. They highlight the importance of different preferences for new technologies between North and South. For example, the North may prefer to focus pharmaceutical R&D on cancer treatments, while the South may prefer to focus efforts in this area on tropical diseases. However, global R&D resources are scarce and this provides a motive for countries in the South to pursue adequate IPR protection in order to compete for these scarce R&D resources.

More recently, Yang and Maskus (2008) consider North-South relations in terms of market entry strategies and IPRs. Northern firms have a choice between exports or licensing as a market strategy for supplying the South. This decision is based on the level of IPR in the developing country that the Northern firm wishes to enter. Their findings show that enhanced IPR protection leads to technology transfer through licensing and reduces the South's marginal production cost, thereby increasing its exports. Here, absorptive capacity plays an important role in the outcomes, including with respect to welfare.[7]

Summary

This brief review of the literature highlights the importance of technology for economic growth. IPRs appear to play a role in enhancing the incentives for new innovation and diffusion of existing innovation. In turn, the accumulation of technology in the economy that results from this process may influence productivity. From the evidence presented above, it appears that this process may operate in a broad range of developed and developing countries, with implications for growth and comparative advantage.

In this context, it is notable that the levels and evolution in protection for IPRs around the world since 1990 have not been uniform. The next section will consider the variation in IPR protection across countries and the association of change in IPR protection with changes in technological achievement and productivity.

Analytical approach and data

The analytical approach employed is empirical, based on a two equation system implemented using a two step approach.[8] The objective is to examine the relationship of change in IPR protection to change in technological achievement and the relationship of technological achievement to change in labour productivity.

The relationship of IPR protection to technological achievement is estimated in equation (1). The equation was estimated three times, drawing in turn on each of three indices of IPR protection, concerning respectively patent rights, copyrights and trademark rights. Control variables included GDP per capita and FDI inflows, with country fixed effects. All variables were introduced as natural logarithms. The equation considers the relationship using national-level (aggregate) balanced panel data for the years 1990 and 2000. The hypothesis underlying this part of the analysis is that in view of initial weaknesses in IPR protection (relative to current standards) for the countries concerned as of 1990, the strengthening of IPR protection during the subsequent decade would be associated with stronger incentives to innovate and diffuse innovation, and consequently stronger technological achievement.

Equation (2) considered the relationship of technological achievement to labour productivity using balanced panel data for the years 1990 and 2000, controlling for GDP per capita, with country fixed effects. Here as well all variables were introduced as natural logarithms. In order to control for endogeneity of technological achievement, the variable is instrumented using the exogenous variables in the system; for each country three estimates of ^T were developed using equation (1) results for patent rights, copyright and trademark rights. The hypothesis underlying this part of the analysis is that on average relatively higher levels of technological achievement during the period will be associated with relatively greater productivity; this is because greater technological achievement (as measured by the TAI) implies greater capacity to accumulate and diffuse technology across the economy, which can result in greater output per hour worked.

Equations (1) and (2) constitute the core analysis for this chapter. Equation (3) was included as a secondary means of confirming the results of the analysis using equation (2). It is structured in a manner somewhat similar to equation (2), but considers the change in labour productivity over the period as the dependent variable. It employs sector-level data, by country, for the value added per hour and gross output per hour series. The independent variables refer to the initial period. Sector fixed effects are employed. Data limitations required use of a restricted sample for the implementation of equation (3); it could not be estimated using predicted values for technology achievement (see below) based on trademark rights data, and one country dropped out of the sample.

The model as estimated is presented below:

$$\ln T_{it} = \alpha_1 + \beta_1 \ln X_{it} + \eta_1 \ln V_{it} + \eta_2 \ln W_{it} + \Theta_i + \varepsilon_{it} \quad (1)$$

$$\ln Y_{it} = \alpha_2 + \beta_2 \ln \hat{}T_i + \eta_3 \ln V_{i,t} + \mu_i + e_{it} \quad (2)$$

$$\ln \Delta Z_{is} = \alpha_3 + \beta_3 \ln \hat{}T_i + \eta_4 \ln V_i + m_s + e_i \quad (3)$$

Where

T = *Technology Achievement Index* (NB, this variable would be endogenous in equation (2); to circumvent this situation, we instrument for it using the exogenous variables in equation 1 to obtain predicted values. The predicted values are indicated by the following notation: ^T. Separate estimates of ^T were calculated for patent rights, copyright and trademark rights. In equation (3), the predicted values refer to 1990.)

Y = level of value added per hour or gross output per hour worked, national level data, for the periods 1990 and 2000.

ΔZ= change in the value added per hour or gross output per hour worked, sector-level data, by country, for the period from 1990 to 2000.

i = country

s = sector

t = *year* (1990 or 2000)

$\alpha_{1,}$ α_2 and α_3 are *constants*

$\beta_{1,}$ β_2 and β_3 are coefficients for the independent variables of prime interest in the present analysis, namely those concerning protection of intellectual property rights (equation 1) and technological achievement (equations 2 and 3), respectively.

X = a measure of the strength of *intellectual property rights* (Park *et al* indices for patent, copyright and trademark protection, each included in separate iterations of the model),

V = a *control variable*, namely GDP per capita (in equation 3, this refers to 1990 only)

W = a *control variable*, namely inward FDI

Θ = country fixed effects

μ = country fixed effects

m = sector fixed effects

ε and *e* = the *error terms*

ln denotes the natural logarithm.

The data for the analysis were drawn from several sources:

- The *Technology Achievement Index* (TAI) was presented in the World Bank's *Global Economic Prospects, 2008* (WB, 2008). It is based on a broad range of indicators concerning innovation, technological adaptive capacity, channels of technology diffusion, diffusion of recent technologies and penetration of old technologies.[9] All together, there are 34 separate variables underlying the TAI. Aggregation is accomplished using weights calculated by principle components analysis.
- The series on output and productivity were *drawn* from the EU-KLEMS data set, November 2009 release.[10]
- The protection of IPRs is represented by three indices developed by Walter G. Park, American University, and colleagues. The indices measure the strength of IPRs based on laws on the books assessed *using* objective criteria concerning such dimensions as membership in relevant international treaties, statutory laws and legislation, and case law (for details see Park and Lippoldt, 2008). The present analysis employs the Patent Rights Index, Copyright Index and Trademark Rights Index.

- Control variables for equation 1 were drawn from the dataset underlying Park and Lippoldt (2008).
- The combined dataset from these *sources* covered 14 OECD countries: Australia, Austria, Finland, France, Germany, Greece, Ireland, Italy, Japan, Netherlands, Portugal, Sweden, the United Kingdom and the United States. Data by sector were not available for the United States due to different sector classification within the KLEMS dataset; hence, it was dropped from the sample in the implementation of equation (3).

Descriptive statistics for the key variables are presented in Annex Table 9.A1, by year and pooled across time periods. Panel A highlights the complete sample, with all countries covered. In reference to the implementation of equation (3), Panel B highlights these statistics for the sample excluding the United States. As presented in the table, one notable feature of the data concerns the decline in the dispersion of the three IPR indicators between 1990 and 2000. In part, this may be attributed to greater international co-ordination in setting of minimum standards of protection for IPRs, including via the TRIPS Agreement that came into effect in 1995. In comparison to developing countries, the advanced economies in the present sample were extended less flexibility under the TRIPS Agreement and hence one might expect relatively smaller variation in the present sample than one would find globally.

Figure 9.A2 presents histograms showing the distribution of scores across the sample for 1990 and 2000, for each of the IPR indices and for the Technology Achievement Index. The scores are displayed in natural logarithms. The figure highlights graphically the increased convergence in the situation of these advanced economies with respect to the subjects covered by these indices.

Results

The analysis found positive and significant relationships in several specifications of the two core equations (1 and 2) and the confirming assessment in equation (3). The results point to a positive and statistically significant relationship between two indicators of IPR protection and technological achievement (Annex Table 9.A2). The relationship between such achievement and value added per hour – a key indicator for labour productivity – was also positive and significant (Annex Table 9.A3).

As can be seen from Annex Table 9.A2, with respect to protection of patent rights and trademark rights as measured by the two corresponding indices, the coefficients were positive and statistically significant (at the 0.1 and 0.05 levels, respectively). The control variables were also positive and significant. On average, a change of 1% in the Patent Rights Index, for example, was associated with a change of 0.31% in the Technological Achievement Index. The comparable result for trademarks was 0.17%. On the other hand, the coefficient for copyright was not significant. While this type of analysis does not determine causality, from these results it appears there is a clear association between the generally strengthened IPR protection for patents and trademarks and technological achievement during the period 1990 to 2000.

A further result of interest for comparative advantage can be seen in the positive and significant results with respect to the control variable, namely FDI inflows. Our results appear consistent with the notion of FDI as one hypothesized path of technology transfer, as suggested by others in the literature (Keller, 2007; Maskus, 2004). The parameter estimates in Annex Table 9.A.2 relating to inward FDI suggest this dynamic since they are all positive and statistically significant. For example, in column (1) a 1% increase in inward FDI is associated with a 0.18% increase in technology achievement for the case of patents. Similarly, in columns (2) and (3), a 1% increase in inward FDI is associated with increases in technology achievement of 0.20% and 0.16%, with respect to copyrights and trademarks, respectively. Taken as a set, these results complement the evidence from the IPR indicator and suggest that FDI may operate in parallel or joint with IPR protection in relation to technological achievement. Together, they may aid in the diffusion of technology in the countries concerned, facilitating movement towards the world technological frontier and contributing to productivity increases.

The results for labour productivity are also positive and significant in the case of value added per hour (Annex Table 9.A3). Drawing on predicted values for TAI developed in relation to the indices of IPR protection[11], the results from equation (2) show that stronger technological achievement during the decade tended to be associated with increased labour productivity as measured by this indicator. This was not the case for gross output per hour. For example, consider technological achievement as estimated with respect to patent protection. On average, a 1% greater score for technological achievement was associated with a 0.35% greater score in value added per hour during the period between 1990 and 2000. For copyright and trademark protection, the comparable results were 0.40% and 0.42%, and the statistical significance was stronger. Thus, the results are consistent with the hypothesis that stronger technological achievement would be associated with change in labour productivity, at least as measured by value added per hour.[12] Arguably, this is a better indicator of labour productivity than gross output per hour, which does not take into account inputs.

Annex Table 9.A4 presents the results of the supplementary assessment specified in equation (3), considering the change in labour productivity indicators during the decade in relation to the level of technological achievement as of 1990, controlling for GDP. This assessment drew on sectoral data to provide a confirming assessment to the foregoing national-level assessment.[13] While the data limitations required a narrowed focus (with predicted values for technological achievement taking into account either patents or copyright, but not trademarks and the loss of the United States from the sample), it nonetheless provided some encouragement. The coefficients for the relationship of technological achievement were positive across the board. However, they were only significant in the case of change in gross output per hour. Overall, a 1% variation in the initial level of technological achievement as of 1990 was associated with 0.12% and 0.16% change in gross output per hour (depending on whether indicators for protection of patent rights or copyright were used in developing the predicted TAI values). The difference in significance with the foregoing analysis appears to be influenced in part by the different coverage of the sample.

Conclusions

For a sample of advanced economies during the 1990s, this chapter has considered the relationship of changes in IPR protection to technological achievement, and the relationship of technological achievement to labour productivity. With respect to the indicators employed in the analysis, the results point to a positive and significant relationship of patent and trademark protection to technological achievement and, in turn, technological achievement to labour productivity. Taken as a whole, the results indicate that an appropriate degree of IPR protection may constitute one policy complement to be considered in relation to trade and investment policies designed to facilitate realisation of improved economic performance in line with a country's potential comparative advantage.

From the available evidence, it is not clear what is driving the lack of significant relationship of copyright protection to technological achievement. For example, it may be that while copyright protection provides incentives for commercial diffusion of technical knowledge, it may also lead to market power effects that could potentially slow diffusion, and the resulting balance is ambiguous. Hence, it would appear that this issue merits further exploration that goes beyond the scope of the present chapter.

The present empirical analysis was conducted for a particular set of countries, during a specific period of time, with IPR protection being strengthened over a particular range of stringency. Thus, any generalisation should be approached with caution.[14] Nonetheless, on the basis of the statistical evidence presented above, it would appear that technological achievement is one factor correlated with change in labour productivity and that, for policy makers concerned with these matters, IPR protection is one policy dimension that merits consideration.

Notes

1. Ricardo H. Cavazos Cepeda, Director General, Estudios Económicas Comisión Federal para la Protección Contra Riesgos Sanitarios Mexico, and Douglas C. Lippoldt, Senior Trade Policy analyst, Agriculture and Trade Directorate, OECD. The authors wish to thank Michael Hennon, University of Denver, for his capable research assistance. The kind assistance of Andrew Burns, World Bank, is gratefully acknowledged in providing access to the Technology Achievement Index, as is the assistance of Walter G. Park, American University, in providing access to the intellectual property rights indices employed here. The views expressed are those of the authors alone and are not meant to represent the views of the OECD or any of its members.
2. For a detailed explanation about knowledge capital, see Romer (1986) and Grossman and Helpman (1990a, 1990b).
3. Although the TRIPS Agreement was a major factor in strengthening IPR rights around the world during the 1990s, it was not the only one. Others include, for example, increased numbers of ratifications of agreements administered by the World Intellectual Property Organisation, increased numbers of regional trade agreements incorporating IPR provisions, and unilateral (domestic) IPR policy reform.
4. Based on objective criteria for scoring the relevant laws on the books, the Patent Rights Index provides an indication from 0 (low) to 5 (high) for the strength of patent rights in each country (Park, 2008).
5. There are a number of studies that consider the relationship of IPR protection to international economic relationships, generally finding a positive association. These include Fink and Primo Braga (1999); Awokuse and Yin, 2010; Branstetter *et al.*, 2006; Ivus, 2008; Yang and Kuo, 2008; and Javorcik (2004). With respect to FDI and IPR protection, Lai (1998, 2003) and Lai and Qui (2003) note the positive role of IPR in the process of technology transfer and related welfare implications.
6. Lucas (1993) explores the disparate growth rates between Asian countries and argues that the primary driver of economic growth is human capital (knowledge), and that this is therefore the main source of differences between living standards. Hall and Jones (1999) also examine the large differences in worker output between countries, noting that human capital is critical to worker output, high levels of productivity, and long run growth. They argue success in these areas is determined by social infrastructure. That is the institutions and government policies allow individuals and firms to make investments, create and transfer ideas, and produce goods and services.
7. A recent World Bank study explores how developmental and regulatory impediments may constrain the ability of developing countries to adopt new technologies. Such barriers can deter the process of resource allocation and firm creation and destruction, slowing technological adoption and resulting in a failure to catch-up (Bergoeing *et al.*, 2010).
8. The regression analysis was implemented using the STATA statistical package.
9. The data from the WB-TAI for the present analysis cover two time periods, 1990 and 2000.
10. Further information on the EU-KLEMS data set can be found at *www.euklems.net/* .

11. This refers to the predicted values for TAI included in the equation as ^TAI. There were three iterations, each using the different results from the three iterations of equation (1) as calculated for patent rights, copyright and trademark rights.

12. As stated in the foregoing exercise, such evidence of a positive and significant relationship does not demonstrate causality.

13. In preparing this confirming assessment with equation 3, the equations 1 and 2 were rerun excluding the United States from the sample. The results are not presented here due to space limitations, but were very similar in scale, sign and significance to those presented in Tables 9.A2 and 9.A3.

14. For example, one cannot extrapolate from these results to assume that strengthening of IPR protection beyond the range considered here would yield further positive results of similar magnitudes.

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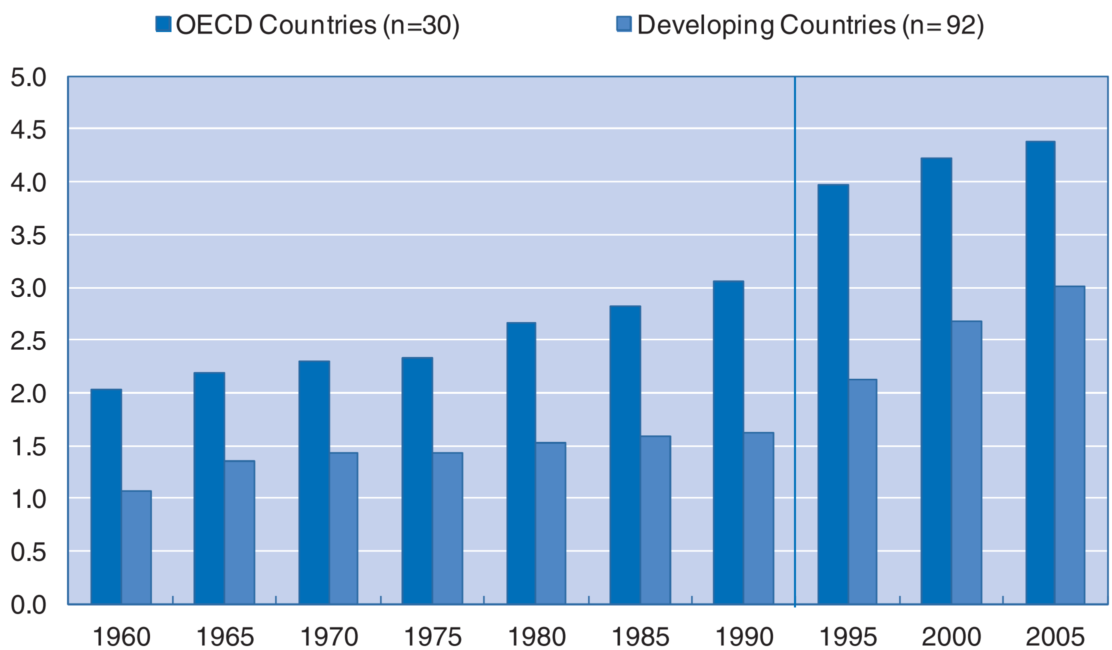
Annex 9.A.
Figures and tables

Figure 9.A1. Index of patent rights based on laws on the books
(0 = weak, 5 = Strong)

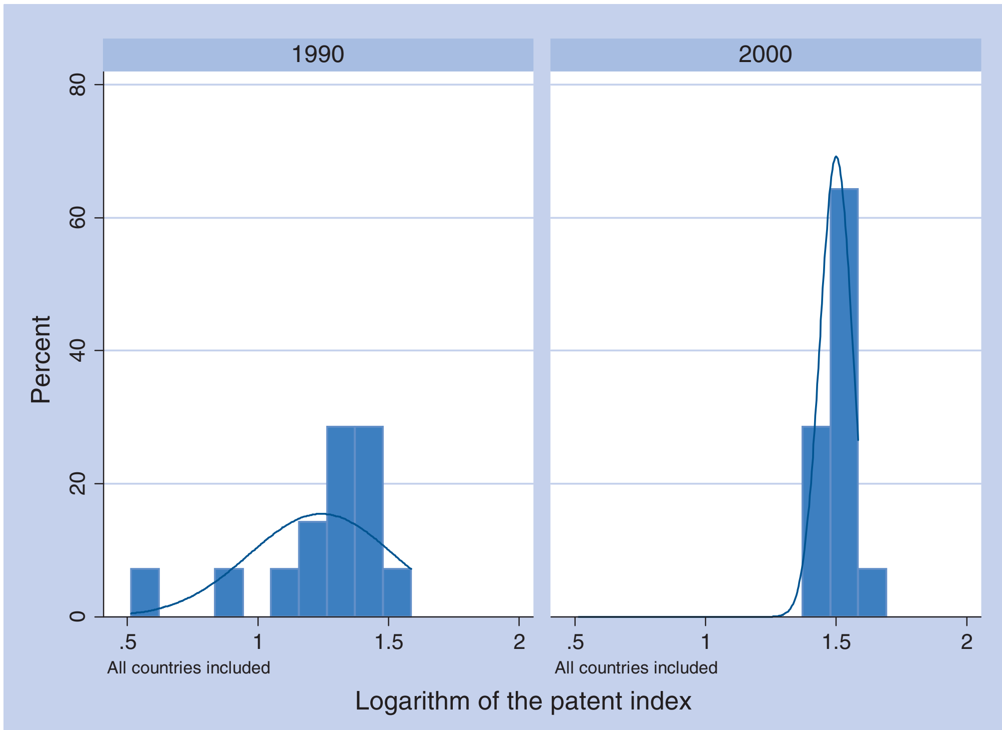


The chart presents the average score for the Patent Rights Index for OECD and developing countries. Using objective criteria, the Patent Rights Index scores the strength of patent rights based on laws on the books. Scores can range from 0 to 5. The thin vertical line represents the advent of the WTO TRIPS Agreement.

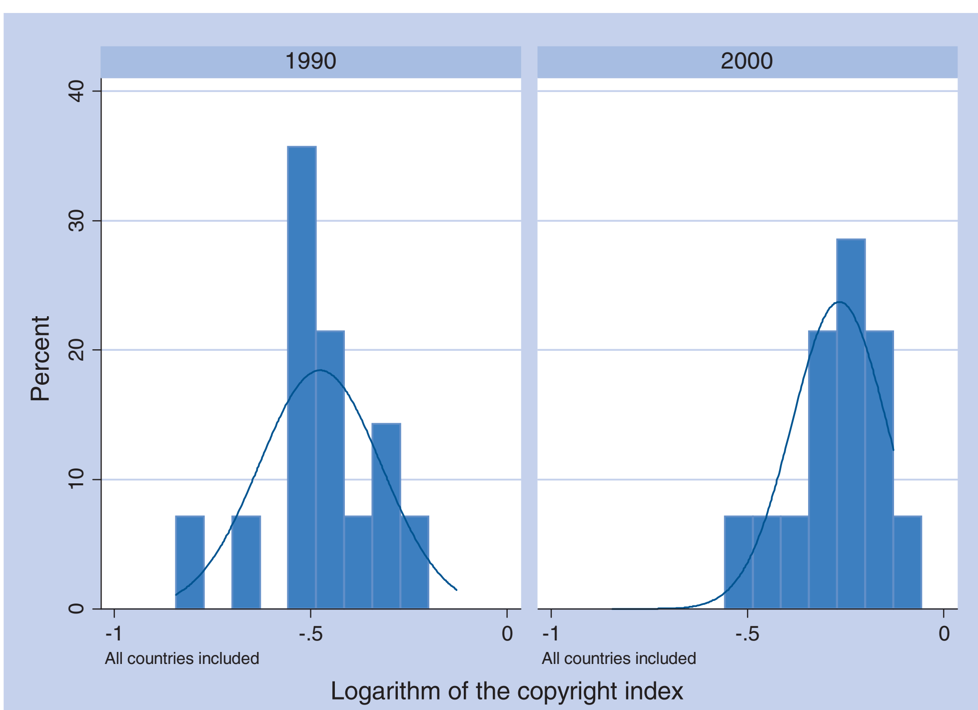
Source: Park and Lippoldt (2008).

Figure 9.A2. Histograms presenting the distribution of the index scores, all countries in the sample, 1990 and 2000

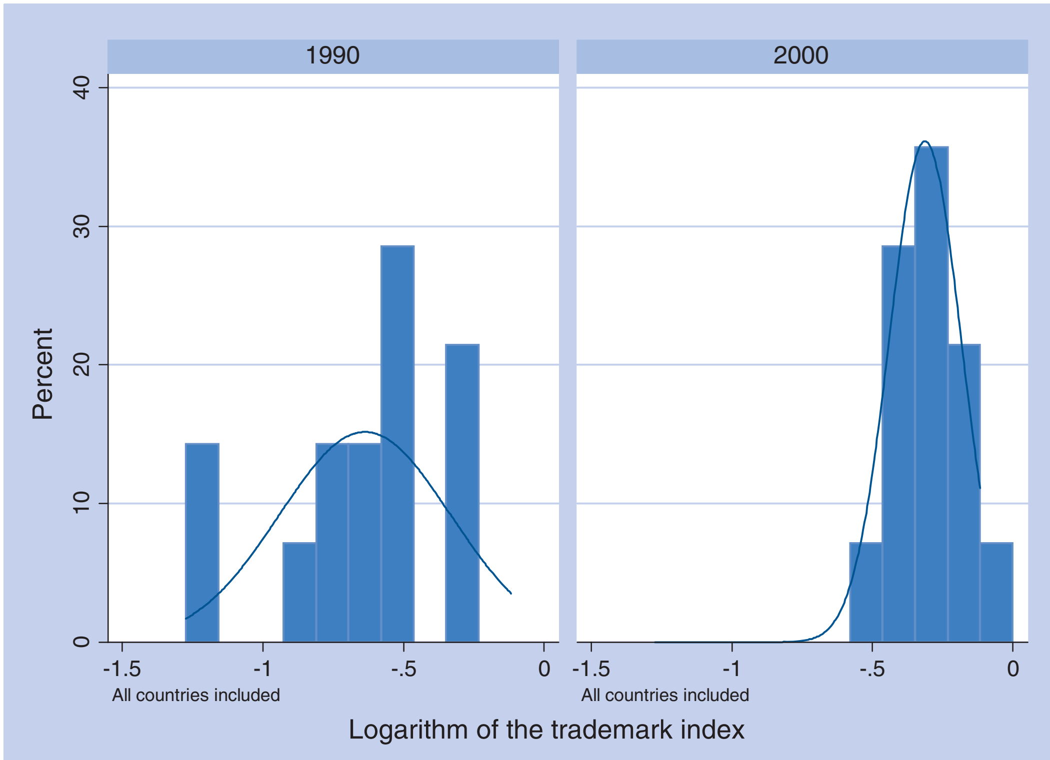
Panel A. Logarithm of the patent rights index scores



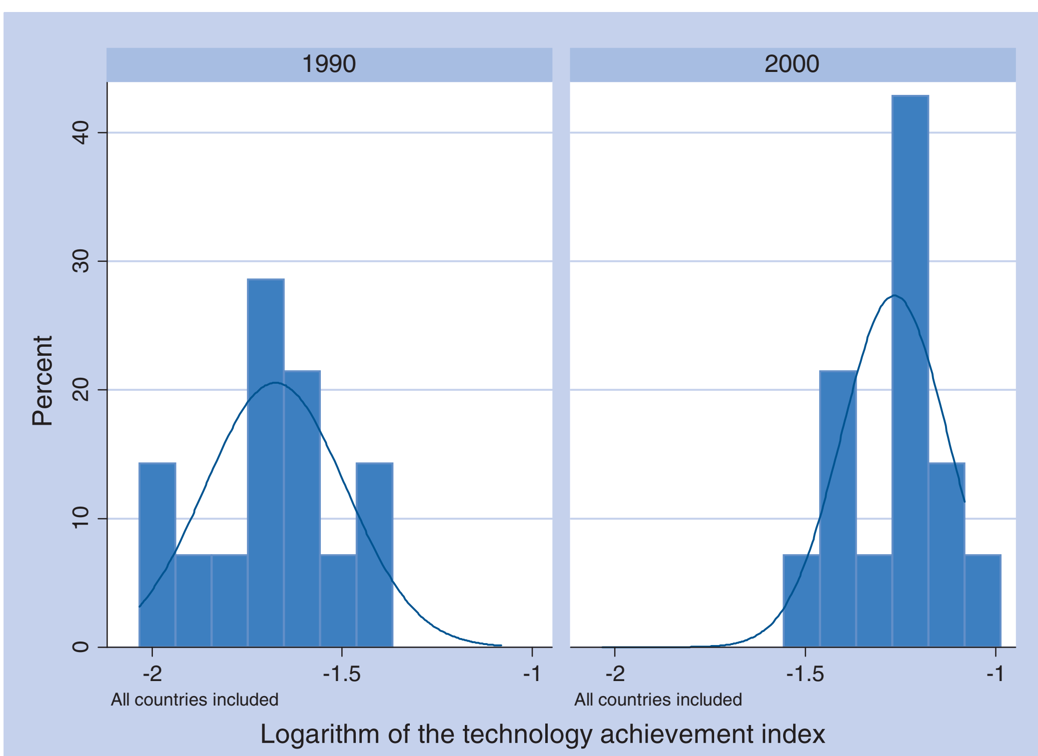
Panel B. Logarithm of the copyright index scores



Panel C. Logarithm of the trademark rights index scores



Panel D. Logarithm of the technology achievement index scores



Annex Table 9.A1. Descriptive statistics for the sample, 1990 and 2000

A. All countries covered

Variable	Observations	Mean	Standard deviation	Coefficient of variation	Minimum	Maximum
Full sample (pooled years)						
Technology achievement index	28	0.24	0.06	0.25	0.13	0.34
Patents index	28	4.03	0.76	0.19	1.67	4.88
Copyrights index	28	0.70	0.12	0.16	0.43	0.88
Trademarks index	28	0.64	0.15	0.24	0.28	0.89
GDP per capita	28	21196.31	7089.87	0.33	8563	36649
Inward FDI	28	158433.70	249445.30	1.57	6289	1256867
Year 1990						
Technology achievement index	14	0.19	0.03	0.18	0.13	0.24
Patents index	14	3.57	0.82	0.23	1.67	4.68
Copyrights index	14	0.63	0.09	0.15	0.43	0.79
Trademarks index	14	0.55	0.15	0.27	0.28	0.78
GDP per capita	14	19033.74	6566.82	0.35	8563	33280
Inward FDI	14	97212.54	130232.80	1.34	6289	483933
Year 2000						
Technology achievement index	14	0.28	0.04	0.14	0.22	0.34
Patents index	14	4.49	0.27	0.06	3.97	4.88
Copyrights index	14	0.77	0.09	0.12	0.59	0.88
Trademarks index	14	0.74	0.09	0.13	0.58	0.89
GDP per capita	14	23358.89	7155.63	0.31	10497	36649
Inward FDI	14	219654.80	322798.80	1.47	14113	1256867

Covers all countries in the sample, including the United States.

B. All countries covered, excluding the United States

Variable	Observations	Mean	Standard deviation	Coefficient of variation	Minimum	Maximum
Full sample (pooled years)						
Technology achievement index	26	0.23	0.06	0.25	0.13	0.34
Patents index	26	3.97	0.76	0.19	1.67	4.67
Copyrights index	26	0.69	0.11	0.16	0.43	0.87
Trademarks index	26	0.64	0.16	0.25	0.28	0.89
GDP per capita	26	20409.03	6667.82	0.33	8563	36649
Inward FDI	26	103667.00	107616.10	1.04	6289	438631
Year 1990						
Technology achievement index	13	0.19	0.03	0.17	0.13	0.24
Patents index	13	3.49	0.78	0.22	1.67	4.34
Copyrights index	13	0.62	0.09	0.14	0.43	0.79
Trademarks index	13	0.55	0.15	0.28	0.28	0.78
GDP per capita	13	18323.83	6250.85	0.34	8563	33280
Inward FDI	13	67464.85	70374.68	1.04	6289	249870
Year 2000						
Technology achievement index	13	0.28	0.04	0.13	0.22	0.34
Patents index	13	4.46	0.26	0.06	3.97	4.67
Copyrights index	13	0.76	0.09	0.11	0.59	0.87
Trademarks index	13	0.74	0.10	0.13	0.58	0.89
GDP per capita	13	22494.22	6643.09	0.30	10497	36649
Inward FDI	13	139869.20	127809.80	0.91	14113	438631

Covers all countries in the sample except the United States.

Table 9.A2. The relationship of intellectual property protection to technological achievement, 1990 to 2000

Variables	(1) Log of technology achievement index	(2) Log of technology achievement index	(3) Log of technology achievement index
	(IPR Index = Patent Rights Index)	(IPR Index = Copyright Index)	(IPR Index = Trademark Rights Index)
log per capita GDP	0.640*	0.996***	0.857***
	(0.351)	(0.312)	(0.236)
log IPR index (either patent, copyright or trademark)	**0.307***	**-0.0266**	**0.170****
	(0.161)	**(0.280)**	**(0.0667)**
log of inward FDI	0.176***	0.195**	0.158***
	(0.0474)	(0.0724)	(0.0359)
constant	-10.16***	-13.51***	-11.66***
	(2.998)	(2.841)	(2.080)
Observations	28	28	26
Number of countries	14	14	14
R-squared	0.932	0.918	0.942

1) The countries covered include Australia, Austria, Finland, France, Germany, Greece, Ireland, Italy, Japan, Netherlands, Portugal, Sweden, the United Kingdom and the United States.

2) Country fixed effects are included in these regressions.

3) Robust standard errors are shown in parentheses; *** p<0.01, ** p<0.05, * p<0.1.

Source: Authors' calculations.

Table 9.A3. The relationship of technological achievement to labour productivity, country basis

1990 to 2000

Variables	**Value added per hour**	**Gross output per hour**	**Value added per hour**	**Gross output per hour**	**Value added per hour**	**Gross output per hour**
	^T value inferred using Patent Rights Index		^T value inferred using Copyright Index		^T value inferred using Trademark Index	
log per capita GDP	0.0462 (0.228)	0.302 (0.353)	-0.0262 (0.237)	0.183 (0.364)	-0.0028 (0.212)	0.202 (0.332)
Log Technology Achievement Index (predicted values, ^T)	**0.354*** **(0.166)**	**0.275** **(0.257)**	**0.401**** **(0.165)**	**0.352** **(0.252)**	**0.420**** **(0.166)**	**0.396** **(0.246)**
Constant	4.554* (2.498)	2.609 (3.862)	5.339* (2.581)	3.898 (3.966)	5.195** (2.348)	3.818 (3.651)
Observations	28	28	28	28	26	26
Country ID	14	14	14	14	14	14
R-squared	0.825	0.760	0.834	0.774	0.853	0.824

1) The countries covered include Australia, Austria, Finland, France, Germany, Greece, Ireland, Italy, Japan, Netherlands, Portugal, Sweden, the United Kingdom and the United States.

2) Country fixed effects are included in these regressions.

3) Robust standard errors are shown in parentheses; *** p<0.01, ** p<0.05, * p<0.1

Source: Authors' calculations.

Table 9.A4. The relationship of technological achievement to change in labour productivity,

Sectoral basis, 1990 to 2000.

Variables	Change in value added per hour, from 1990 to 2000	Change in gross output per hour, from 1990 to 2000	Change in value added per hour, from 1990 to 2000	Change in gross output per hour, from 1990 to 2000
	(^T value inferred using Patent Rights Index)		(^T value inferred using Copyright Index)	
log per capita GDP (as of 1990)	-0.0405	-0.103	-0.101	-0.173**
	(0.0787)	(0.0715)	(0.0928)	(0.0857)
Log Technology Achievement Index (predicted values, ^T, as of 1990)	**0.0344**	**0.115***	**0.0821**	**0.155****
	(0.0758)	**(0.0663)**	**(0.0751)**	**(0.0675)**
Constant	0.327	1.137	1.012	1.888*
	(0.910)	(0.830)	(1.051)	(0.973)
Observations	180	180	180	180
Country ID	13	13	13	13
R-squared	0.109	0.263	0.115	0.274

1) Robust standard errors in parentheses; *** p<0.01, ** p<0.05, * p<0.1

2) The countries covered include: Australia, Austria, Finland, France, Germany, Greece, Ireland, Italy, Japan, Netherlands, Portugal, Sweden, and the United Kingdom. Due to lack of data the United States is not covered.

3) Due to a lack of sectoral data for several countries, no comparable regression could be produced for technology achievement inferred using the Trademark Index.

4) Sector fixed effects are included in these regressions. The sector fixed effects take into account 15 major sectors covering virtually all of the economy: agriculture, hunting and forestry; mining and quarrying; total manufacturing; electricity, gas and water supply; construction; wholesale and retail trade; hotels and restaurants; transport and storage and communication; financial intermediation; real estate, renting and business activities; public administration and defence; compulsory social security; education; health and social work; other community, social and personal services; and private households with employed persons. No data were available concerning the sector "extraterritorial organisations and bodies."

Chapter 10

The impact of export restrictions on raw materials on trade and global supply

by
Frank van Tongeren[1]

Export restrictions on raw materials accentuate the challenge of supplying raw materials in a world market context of sharply rising commodity prices. The economic effects of export restrictions are overwhelmingly negative. By diverting exports to domestic markets, export restrictions raise prices for foreign consumers and importers while increasing global uncertainty and negatively affecting investment in extraction and production. Timely and accurate information about government policy is a necessary condition for predictability of supply and risk management in production. This paper presents preliminary findings from an ongoing OECD initiative attempts to contribute to improved transparency by constructing an inventory of export restrictions on critical raw materials.

Import barriers have historically figured prominently in the arsenal of policies that provide domestic industries with an advantage at the expense of suppliers from other countries. More recently export restrictions on raw materials have come to the fore. They divert raw material supplies to domestic markets, providing downstream industries with cost advantages and limiting supply to world markets.

The increasing use of export restrictions on raw materials and steep price rises in recent years have alerted policy makers and the business community in industrialized countries to the raw materials supply challenge. Rapid industrialisation in emerging economies and population growth put increasing pressure on a range of raw materials, from agricultural commodities to metals and minerals. After years of underinvestment the supply response to growing demand for natural resources is slow, leading to price rises and increased rates of return in natural resource-based activities. Several mining companies and related upstream suppliers have recently made remarkable moves towards the top of global lists that rank companies by market value (*The Financial Times*, 25 June 2011). This is also the case for some of the big agricultural commodity traders and equipment suppliers.

Availability of certain materials is critical for many industrial sectors, especially in high-tech (e.g. mobile phones) and 'green' industries (e.g. wind turbines, hybrid vehicles) (US Department of Energy 2010). Although a material may be used in small quantities it is often essential for the development of technologically sophisticated products with no good substitutes in the short term. Hydrogen fuel based cars, for example, require platinum-based catalysts; electric-hybrid cars need lithium batteries; rhenium super alloys are an indispensible input for modern aircraft production. The European Commission has stated that the European Union will not accomplish the shift towards sustainable production and environmentally friendly products without such metals (EC, 2008).

Geographical concentration of supply is a salient feature of many critical raw materials. For most of the critical raw materials discussed in Korinek and Kim (2010), the top three producing countries account for over half of world production. For some raw materials, close to the entire world production takes place in just three mining regions. This is the case for rare earths, where 99.7% of world production occurs in the top three producing countries, and for vanadium (98%), antimony (95%), platinum (93%), and gallium and germanium, where all of world production occurs in two or three countries. However, in some cases the known reserves are more geographically dispersed than current production, suggesting that it has not been economically viable to bring those reserves under production.

The technological dependence on some critical raw material inputs in combination with the geographical concentration of their production presents a risk to the supply chain for industries. This risk is further accentuated by producer-country policies that restrict exports. Those policies undermine the trust in the international market as a reliable source of supplies and they hamper an economy's ability to efficiently specialise production. Supply risk is a cost factor for importing industries. For the raw materials exporter, an export restriction typically reduces profitability and clouds long term prospects by introducing uncertainty and artificially keeping domestic prices low.

This chapter first provides an overview of recent developments in export restrictions on raw materials, discussing the various forms, their stated rationales and their incidence. It then discusses the economic effects of export restrictions, including some of the unintended domestic and international side-effects that limit their effectiveness in view of their stated objectives. It argues that in many cases export restrictions are not in the best interest of countries applying them and can have detrimental effects on international markets. The chapter concludes that more transparency on export restrictions is needed in view of the weak multilateral rules that could effectively discipline countries in applying those measures, and it argues for work on developing policy alternatives to support such objectives as environmental protection and conservation of natural resources.

The *what*, *why* and *who* in export restrictions

What are export restrictions?

There are many policy measures that can restrict exports. A WTO Dispute Settlement Understanding panel, in the context of the application of the Subsidies and Countervailing Measures (SCM) Agreement, delineated the scope of export restraints as:

> *A border measure that takes the form of a government law or regulation which expressly limits the quantity of exports or places explicit conditions on the circumstances under which exports are permitted, or that takes the form of a government-imposed fee or tax on exports of the products calculated to limit the quantity of exports.*[2] *(World Trade Organization, 2001, page 75, paragraph 8.17)*

To obtain an exhaustive list of export restrictions, other measures must be added. These often operate behind the border with effects on trade that are more indirect.

Table 10.1 lists types of export measures that are monitored in an ongoing OECD effort to compile export restrictions on strategic raw materials.

Table 10.1. Types of export measures recorded by various sources

Export taxes or duties	Reduction or withdrawal of VAT export rebate
Special export surcharges	Restriction on customs clearance points for exports
Fiscal taxes on exports	State trading enterprise
Export quotas	State controlled enterprise engaged in trade
Export prohibitions	Qualified exporters list
Export licensing/permit requirements	Domestic market obligations
Minimum export price/export floor price	Local processing requirements
Price reference for exports	Captive mining
Dual pricing schemes	

Source: compiled by the OECD.

One of the most popular forms of export restrictions is export duties. A variety of similar or complementary terms (such as export taxes, export tariffs, export fees, export charges, and export levies) are used to describe what is essentially a tax that exporters must pay when their products leave the country. Export duties can take different forms. It can be an *ad valorem* tax, specified as a percentage tax of the value of the product; or a specific tax, specified as a fixed amount to pay per unit of a product. All types of export taxes have the effect of raising the cost of exports and if demand is price elastic, reducing the volume of exports. A minimum export price or a reduction of VAT rebate rates produces effects similar to export duties.

The most extreme case of restrictions which directly affect the quantity of exports is an export prohibition. A less severe form, export quotas are restrictions or ceilings imposed by an exporting country on the total volume of certain products. Export license requirements establish that an application or other documentation should be submitted as a condition for exportation and depending on whether license acquisition is automatic the requirements may affect the volume of exports. Despite the potentially negative impact on exports, export licensing has drawn relatively less attention, partly because it is difficult to acquire information on this measure.

Some of the measures listed in Table 10.1 explicitly attempt to divert exports towards the domestic market, typically to foster domestic processing of the raw materials. Also, governments can influence the level, direction and prices of exports through state-owned enterprises, for example by giving them exclusive or special export rights. Exports can also be reduced by introducing tax arrangements which discourage exports, or by removing export-inducing tax arrangements.

Export taxes are relatively more prevalent than other export restrictions. This can be partly explained by the unevenly developed GATT/WTO disciplines. Existing multilateral rules generally prohibit quantitative export restrictions but have less to say about price measures. While there is no single GATT/WTO article dealing exclusively with export restrictions, Article XI of the GATT 1994 is the key provision. It prohibits the use of quantitative restrictions regarding both imports and exports. It states that:

> *"no prohibitions or restrictions other than duties, taxes or other charges, whether made effective through quotas, import or export licenses or other measures, shall be instituted or maintained by any contracting party (on the importation of any product destined for the territory of any other contracting party or) on the exportation or sale for export of any product for the territory of any other contracting party."*

Therefore, in contrast to quantitative restrictions, export duties are in principle not subject to Article XI and thus not prohibited under this article.

While quantitative restrictions are generally prohibited, they can be exceptionally allowed under Article XI:2 (a) (critical shortage of foodstuffs), Article XX (General Exceptions) and Article XXI (Security Exceptions). Article XI:2 (a) allows each Member to apply export restrictions "temporarily" to prevent or relieve "critical" shortage of foodstuffs or other products essential to the exporting country. Article 12 of the Agreement on Agriculture (disciplines on export prohibition and restriction) stipulates in detail when quantitative restrictions on exports are exceptionally allowed. Article XX of the GATT allows exceptional quantitative restrictions for policy objectives such as conservation of exhaustible natural resources, and ensuring essential materials for domestic processing industry under "certain qualifications." However, the article also makes it clear that the exception should not be abused for protection purposes. Article XXI exception applies to measures for the purpose of national security. No provisions specifically require a binding obligation of export duties like import duties under Article II:1 (b) of the GATT 1994.

Additional disciplines exist for new WTO members that have committed to bind their export duties in the context of their accession to the WTO. Notably in the case of China, there is a commitment to eliminate all export duties except on 84 scheduled items. The schedule indicates the rate of bound export duties. Binding export restrictions has also been amongst the topics in the discussion on Russia's accession. These commitments however are exceptions. In contrast to the strict requirements that cover import tariffs, there are no applicable WTO provisions mandating the scheduling or notification of export duties.

Why are export restrictions used?

Restricting exports may seem a counter-intuitive policy choice. Is it not killing the goose that lays the golden eggs? Countries cite a variety of reasons for imposing restrictions on exports of raw materials. Those include the conservation of natural resources where strong export demand increases the rate of extraction beyond levels that are considered optimal. When the extraction of the natural resource has negative environmental effects, protection of the environment may be another reason to restrict exports. In the context of the food price spikes during 2007/08 several grain exporters resorted to export restrictions in order to divert supplies to the domestic market, in an attempt to dampen domestic food price inflation (OECD, 2009).

For countries with a poorly developed tax system, the taxation of exports may be the only available feasible alternative to generating fiscal revenues. In some cases, export taxes represent a significant share of fiscal revenues. In Argentina, for example, income from export duties represented 9.9% of total public revenue between 2002 and 2005. In Malaysia revenue from export duties was at 2.5% of total tax revenues in 2008, with little change since 2004. The figure for Cameroon was 0.6% in 2006, but as high as 1.7% in 2004 and 3.6% in 2002.[3] In countries whose economy depends on natural resource exports, an export tax may be a way to capture some of the rents generated in the extracting industries. This holds in particular if mining rights are granted to foreign companies, and if no effective provisions exist to recycle some of the revenues to the domestic economy.

Although rarely mentioned as an explicit objective, the promotion of downstream industries is another consideration motivating governments to use export restrictions as an industrial policy tool. For example, China applies export restrictions on some rare earths as well as on coking coal as elements of a policy set that aims at restructuring fragmented and inefficient mining sectors as well as to increase the domestic absorption of those raw materials (Price and Nance, 2010; Government of the People's Republic of China, 2011). Likewise, India applies a 'captive mining' policy and export restrictions on coking coal in order to avail domestic steel makers with this input at lower than world market prices (Indicus Analytics, 2009).

The arguments for export restrictions outlined above relate to domestic market failures or to governance failures. Trade policy instruments are typically not the best instruments to address these market failures as they are untargeted to the specific problem and have various side effects, highlighted below, that limit their efficiency and effectiveness. First-best policies would seek to remedy the specific market failure at its root (Corden, 1997). For example, to tackle negative environmental externalities associated with mining, specific environmental policies, including regulation (e.g. emission standards, mining waste controls) and tax instruments, could be developed.

A policy-driven diversion of raw materials to domestic downstream industries would seem to go against the economy's comparative advantage, and would be difficult to sustain in the long run as it reduces the profitability of the raw materials sector and hence has long run effects on investment and production capacity.

An exception is the case where importing countries' trade policies distort market incentives and hence the ability for countries to specialize according to their comparative advantage. Natural resource endowment being one of their most important sources of comparative advantage, many developing-country exporters of primary commodities are trying to build up downstream processing industries as part of their economic development programmes. Tariff escalation used by importing countries can prompt exporting country governments to apply export restrictions on raw materials in order to promote their downstream industries. In this case, the export restriction is aiming at neutralizing the effects of higher tariffs for processed products relative to raw materials, which will decrease the profitability of selling abroad and can hamper industrialisation. Clearly, the first-best solution would be to address tariff escalation, while an export restriction superimposes additional distortions on the already existing ones caused by import barriers for processed products.

The assessment of the merits of export restrictions on raw materials to promote development of downstream industries is not straightforward and still underexplored in the literature. The literature on trade-focused industrial policy (e.g. Melitz, 2005; Rodriguez-Clare, 2007) highlights the very stringent conditions under which temporary import protection might be successful in kick-starting growth in one sector. The central notion is that because of some market failures or institutional impediments, so-called Marshallian externalities (i.e. external to the individual firm, but specific to an industrial cluster) remain unexploited, and hence the economy does not specialize in the activity where it has a latent or dynamic comparative advantage. The extensive empirical literature reviewed by Harrison and Rodriguez-Clare (2009) shows that the conditions needed for this kind of infant-industry protection to yield higher growth in developing countries are often not satisfied, although there are some positive exceptions. In addition, there are huge methodological problems in assessing whether overall economic welfare has actually increased when protected sectors grew faster.

Who is using export restrictions?

During the 2003-2009 period, 65 out of 128 countries in WTO Trade Policy Reviews (TPR) applied export taxes (Kim, 2010). This is an increase compared to 1997-2002 when 39 of 100 WTO Members were reported to uses these measures (OECD 2003).[4] On a regional basis, the biggest increase in the number of countries imposing export duties is recorded in the Americas and Africa. Export duties were imposed mainly by developing and least developed countries during the period 2003-2009 (Table 10.2).

The products most affected by export duties are agricultural products, mineral and metal products, leather, hide and skin products, forestry products, and fishery products (Table 10.3). According to the World Trade Report 2010 (WTO, 2010), export duties cover more than 15% of world trade in the sector of fish and forestry products, around 11% of trade in mining products and less than 7% of trade in fuels.

Information on quantitative export restrictions is less systematically available. Although the WTO TPR country reports describe export prohibitions and export licensing in various ways they are difficult to summarize in a standardized format. Where information exists, it relates typically to quantitative restrictions that are applied in relation to Articles XI:1(a), XX and XXI of GATT 1994. This includes conservation of exhaustible natural resources, environmental protection, and control of weapons and arms trade. In some multilateral agreements or arrangements, the legitimacy of export restrictions is well recognised, particularly in such areas as security, life, public health, safety and environmental reasons. A good example is CITES, the convention on international trade of endangered species of fauna and flora. The existence of such non-WTO multilateral agreements explains why most WTO members maintain quantitative restrictions on exports of some products.

Table 10.2. Number of countries applying export duties, by regions and other groupings, 2003-2009

	Number of WTO Members reviewed by TPRB	WTO Members imposing export duties
Europe/Middle East	39	4
America	31	18
Asia/Pacific	23	13
Africa	35	30
Total	128	65
LDCs	25	21
OECD	31	4
Others	72	40

Source: Compiled from WTO TPR reports from 2003 to 2009. Some Members were reviewed two or three times, but are here counted as one. The European Union is counted as 25 (considering two other countries were under TPR review during this period before they became EU members).

Table 10.3. Export duties by product, 2003 – 2009

Selected products	Number of WTO members applying export duties (based on 65 TPRs)
Forestry products	15
Fishery products	13
Mineral products, metals, precious stones	28
Leather, hides and skins	17
Agricultural products (sugar, coffee, etc.)	36

Source: Compiled from WTO TPR reports from 2003 to 2009. TPR reports do not specify precise HS number of products subject to export duties. This classification is based upon the description of the products in the reports. In this table, hides and skins have been grouped with leather rather than agricultural products. Products listed are not exhaustive; comprehensive details are found in OECD (2010a).

Still much less is known about other types of measures listed in Table 10.1. Apart from a recently launched data-collection effort in the OECD, there are no known mechanisms or initiatives for systematically taking stock of their use, through formal GATT/WTO notification obligations, contrary to what is established practice for import restrictions.

Table 10.4 shows preliminary results from the OECD inventory under construction. While these preliminary data confirm the relative prevalence of export taxes, they also show widespread use of licensing requirements and provide evidence of the diversity of measures actually applied. Some categories of minerals and metals, especially non-ferrous metals and metal scrap, appear far more affected than others.

Table 10.4. Incidence of export measures in the minerals and metals sector, 2009

Type of measure	Number of measures								
	Ferrous metals	Inorganic chemicals	Minerals	Non-ferrous metals, base metals	Non-ferrous metals, minor metals	Precious and semi-precious stones	Precious metals	Scrap	Grand total
Captive mining	2		4		1				7
Export prohibition	1		5					62	68
Export quota	2	1	7	7	29		1	1	48
Special export tax			2		4				6
Export duty	33		22	190	190	25	31	193	684
Fiscal tax on exports				2					2
Licensing requirements	32	4	94	71	219	94	67	148	729
Qualified exporters list						6	6		12
Restriction on customs clearance point for exports								10	10
State controlled enterprise engaged in trade			2			3	2		7
State trading enterprise					10	3	7	1	21
Other export measures	9					14	4	3	30
Grand Total	79	5	136	270	453	145	118	418	1624

Source: compiled by OECD from information available on governmental websites of producer countries. Figures are preliminary. They refer to frequency counts at the HS-6 level of product classification, for a total of 64 countries.

Economic effects of export restrictions

The economic effects of export restrictions are relatively well understood. Bouet and Laborde (2010) argue that export taxes and import tariffs exhibit strong similarities, and are even equivalent in terms of their impact on (domestic and foreign) welfare.

For the importing country the direct effect of an export tax is an increase of the import price and, depending on the price elasticity of imports, a decrease of the import volume for a given product. Export quotas or bans indirectly increase import prices through a reduction of world supply. These effects are especially strong if the exporting country taking the measure is a large supplier of the world market. Faced with this situation, importing countries will typically try to switch to other available sources of supply. Substitutes, however, can be costly or even unfeasible in the short-term, depending on the product concerned.

Concomitantly, by imposing export restrictions, the exporting country diverts supply of the raw materials from the global market to its domestic market. This diversion lowers domestic prices and so provides a cost advantage to local downstream industries, while at the same time penalising local producers of raw materials. In the absence of market failures, the net effect on the country's welfare is unambiguously negative. The only instance where the exporting country can hope to reap net welfare gains from an export tax or quota is if it has such a large share of the world market that it can improve its terms of trade by influencing world price unilaterally. This case is not purely theoretical because, for certain agricultural and mineral commodities, some producer countries may indeed possess substantial power over prices due to their important world market share. Being dependent on their exports, importing countries then have no choice but to pay a higher price for the product given a duty or quota, thus incurring a welfare loss. It can be shown that while the exporting country may gain, on balance its policy still means a net loss of welfare to the world (OECD, 2010a; Bouet and Laborde, 2010).

If a raw material is in some sense critical for the industrial sector of importing countries then imports are insensitive to price changes, at least in the short run. If the inelastic demand is met from a dominant supplier, such as is the case for a range of critical metals and minerals, an export tax may not lead to significant diversion to the domestic market. As importing countries have no alternative supplier, the main effect will be an increase of world prices, while demand continues to be driven by the volume of production of the processing industry in the importing country. In such a situation, the distributional effects prevail, as a larger share of economic rents accrue to the exporting country's government. In contrast to a tax, a quantitative restriction on exports of the critical raw material could be successful in diverting supplies to the domestic market.

In the long term, lower revenues in the primary commodity sector of the exporting country may have the effect of discouraging investment and production, and thus stifle the country's ability to exploit its "natural" comparative advantage. For non-renewable raw materials, such as minerals, substantial and consistent investment is crucial for managing exploration and exploitation of reserves in a manner that ensures steady supply of the resource for foreign sales or domestic use over the long term and a sustainable source of income for the country in question. The imposition of export restrictions can dampen this investment.

The development of downstream industries depends not only on the availability of cheap raw materials inputs. Other factors, such as infrastructure and transport costs, the geographic location of major markets, energy costs, are other significant determinants of such industries. Indeed, the further one moves downstream in the production process from mining to mineral processing, the link between mineral endowment and output becomes weaker (Tilton, 1992). For high-value added downstream industries, such as high-tech alloys, the comparative advantage lies in highly skilled labour and infrastructure, and the specific raw material may represent only a small share of costs. In this case a lower, policy-driven input price may not have a large effect on developing the downstream industry. Complementary policies and institutions would be needed more to overcome those constraints to industrial developments than artificially cheap raw materials inputs (Rodrik, 2008).

The price gap created between the world and the domestic prices can have further effects. When this gap is sufficiently large there is a strong incentive for locals to engage in illegal trade so as to obtain the higher price prevailing abroad. To contain illegal selling the government may have to incur additional expenses, which tie up resources, and could potentially offset revenue generated through the imposition of the export tax, and which the economy could have usefully employed elsewhere.

Mutually spiralling export restrictions represent a real threat to global markets. If an exporting country moves to reduce exports, other competing supplier countries may in turn introduce export restrictions of their own for fear that their domestic processing industry will be disadvantaged *vis-à-vis* foreign competitors. This 'bandwagon effect' can severely disrupt global markets and will also backfire on the export restricting country. If prices of other major suppliers also rise foreign demand will have less scope to shift, resulting in a smaller diversion to local markets and a thus a smaller local cost advantage. Only by moving to raise export taxes even further could the exporting country now keep the domestic price below the world price, but this could encourage another round of restrictions.

The next section provides some examples of some of the adverse effects of export restrictions on world markets and on their limited effectiveness in achieving their stated objectives.

The inefficiency and ineffectiveness of export restrictions

World market effects: Export restrictions during food price spike 2007/08

International prices for some agricultural commodities began to rise sharply in 2006. This initially occurred for wheat and maize, and subsequently for dairy products and oilseed crops. International market prices for these commodities more than doubled in nominal terms between the beginning of 2005 and the end of 2007, and continued to rise rapidly for some through the first six months of 2008 before starting to decline again in the latter half of that year. International prices for rice, which had been increasing at a slower pace, tripled between January and May 2008.

When world grain prices started rising sharply, several exporting countries attempted to stem the domestic food price inflation by restricting grain exports. Amongst those countries were China, India, the Russian Federation and Ukraine. Viet Nam, the second largest rice exporter, banned rice exports during the first few months of 2008. These export restrictions contributed to further world price rises in a situation where markets were already very tight (OECD, 2009). This in turn led to panic reactions amongst some importing countries that attempted to secure grain supplies. Countries in the Middle East began buying wheat on international markets in an attempt to replenish stocks. With prices already being high this pro-cyclical behaviour was not only costly for the buyers, but also contributed to further price rises. Other countries, such as Brazil, lowered import tariffs and started releasing grain stocks. Having lost their trust in the international markets, some tried to secure long term contracts with their suppliers. The Philippines, for example, concluded a three-year contract with Vietnam for the annual supply of 1.5 million tonnes of rice. Others, such as China, Korea and Saudi Arabia started buying or leasing land in other regions, mainly Africa, for the production of grains for their own exclusive supplies.

Substitution to other suppliers: India chromite export tax

Substitution to other suppliers is illustrated with the case of chromite in India. Buoyant demand from foreign countries, especially China, made it more attractive to export the products than to supply the domestic market, increasing in turn the domestic price. In response, from 2007, India imposed an export tax in order to provide a greater supply of this mineral to the domestic market.

India is a major producer and exporter of chromite. In 2006, India was the second largest exporter, with a 22.5% share of world export. The main producing countries of chromite ore and chromite concentrates are South Africa, India and Kazakhstan, together representing 70% of 2008 world production as a whole. About 95% of the world's chromite reserves are in Kazakhstan and South Africa. Over 90% of the world's chromite production is converted into ferrochrome, which in turn is mostly used to produce stainless steel (ICDA Statistical Bulletin, 2009; USGS Mineral Commodity Summaries, 2009). China is by far the biggest importer of chromite, accounting for 70% of world imports in 2008 (ICDA Statistical Bulletin, 2009).

After application of the export tax, India's exports of chromite declined sharply from 1.4 million tonnes in 2006 to 0.5 million tonnes in 2008. In China, the reduced imports from India, combined with increased demand of chromite for ferrochrome production more than doubled the import prices in China. The unit value of Chinese imports of chromite increased from USD 171.10/tonne in 2006 to USD 396.84/tonne in 2008 (Korinek and Kim, 2010), and imports from India declined by 59%.

To make up for this decrease in imports, China began sourcing chromite from other countries. The most striking example is South Africa, with imports from that country increasing by 200% from 868 427 tonnes in 2006 to 2 603 517 tonnes in 2008.

This increase in chromite exports to China created concern in South Africa about the long-term profitability of its own downstream ferrochromium industry, which is directly competing with Chinese producers. Implementing new legislation to limit exports of chromite was considered by South Africa in 2007, but did not eventually materialize. If South Africa had applied an export tax, it would have offset the impact of the Indian measure by reducing the price gap between products of India and South Africa. It would likely also have led to a further increase of the international price of chromite, which would in turn have provided an incentive for India to further raise the export tax to achieve the policy objective as originally intended.

Do export restrictions meet their stated objectives?

Export restrictions rarely deliver what governments expect to achieve. This point can be illustrated by the Chinese decision, taken in 2007, to restrain the export of molybdenum. Molybdenum is a strategic material used inter alia in missile and aircraft parts, petroleum refining technologies and high-strength steel. China accounts for around 28% of global production of molybdenum and 44% of known reserves (Korinek and Kim, 2010). Starting in 2007, the government introduced export taxes and quotas, and also cancelled VAT rebates on molybdenum and its derived products. The stated policy objective was to protect the environment. On closer inspection, however, these policy measures prompted increased exportation of downstream products, whereas production of molybdenum continued to rise approximately 30% per year since 2004 (Korinek and Kim, 2010). Clearly, the environment has not benefited from such continued output growth. At the same time, given China's weight as a major supplier, its policy has caused uncertainty and concern about supplies in the global market for this mineral.

Alternative policies to address environmental concerns in mining: Chile copper mining tax

Although theory warns that, in most instances, export restrictions harm the user country as well as its trading partners, the widespread use of these measures shows that governments are at pain to forego their use. Knowledge of alternative policies that work better in achieving the objectives pursued may help overcome this reluctance.

One way of arriving at useful policy reform recommendations is to review individual country experiences with a view to identifying good practice approaches. Chile is an example of a primary goods exporter that does not apply export restrictions. Chile has included provisions that prohibit export restrictions in most of its (numerous) free trade agreements. Chile's policy experience in dealing with the conservation of non-renewable resources provides an example of alternative policy measures. Despite the importance of copper in Chile's economy, the country tackles resource depletion by applying a mining tax on the operating income of mine operators rather than relying on export restrictions. This tax is non-discriminatory, in that it is applicable to domestic as well as foreign buyers, and the revenue generated by this tax is destined for development and innovation projects in the mining and other sectors.

Conclusions

Export restrictions on raw materials accentuate the raw materials supply challenge in a world market context of sharply rising commodity prices. The economic effects of export restrictions are overwhelmingly negative. Export restrictions distort trade flows and affect trade partners negatively. By diverting exports to domestic markets, export restrictions raise prices for foreign consumers and importers. At the same time, by reducing domestic prices in the applying countries and increasing global uncertainty concerning future prices, export restrictions on raw materials negatively affect investment in their extraction and production – potentially reducing the overall supply of raw materials in the long term. Also, export restrictions by one country may create a spiral of restrictions by other countries.

No economy is fully self-sufficient of every raw material and thus countries are in a myriad of ways interlinked through their import and export flows. Although export restrictions are sometimes applied for development purposes, it is noteworthy that developing countries are as equally affected by such measures as are developed countries. It is therefore not merely a "South-North" issue, but requires a coordinated response to minimize the impediments to globally efficient specialisation in production.

Export restrictions affect a wide range of agricultural, forest, minerals and metals products and are applied to achieve diverse set of stated policy objectives, such as fiscal, environmental policy and development policy. This requires an integrated approach which cannot be well addressed trough trade policy alone. While export restrictions are applied to achieve several policy objectives, there exist alternative policy options with less deleterious trade impacts.

Price volatility caused by export restricting measures and lack of transparency in applying them create an unpredictable business environment. The lack of formal mechanisms or initiatives to systematically take stock of their use, contrary to what is established practice for import restrictions through formal GATT/WTO notification obligations exacerbates this uncertainty. Timely and accurate information about government policy is a necessary condition for predictability of supply and risk management in production. An ongoing OECD initiative, preliminary results of which are presented in this chapter, attempts to contribute to improved transparency by constructing an inventory of export restrictions on critical raw materials.

Notes

1. Head of Policies, Trade and Agriculture Division, Trade and Agriculture Directorate, OECD. The author gratefully acknowledges the contributions made by Martin Clever, Barbara Fliess, Jeonghoi Kim, Jane Korinek, Tarja Mard and Silvia Sorescu. This chapter draws on completed (OECD, 2010a) and ongoing OECD work on export restrictions on raw materials.
2. This case deals with the relation between export restrictions and subsidy. The question was whether US regulations that treat a restraint on exports of a product as a subsidy to other products made using or incorporating the restricted product was consistent with the WTO SCM Agreement (WT/DS194/R).
3. These figures are taken from the latest available *WTO Trade Policy Reviews*.
4. In addition, OECD (2010b) documents new export restrictions and removal of export restrictions as policy responses to the economic crisis.

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Chapter 11

Comparative advantage and structural change: Toward a complementary policy regime

by
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This chapter outlines a pragmatic framework for the structural policies needed to complement trade liberalization within the context of comparative advantage. Its recommendations are eclectic — ranging from efforts to identify key areas of market failure to policy experiments and the analysis of successful past experiences in developing institutions and infrastructure. The goal is to strengthen an economy's ability to maximise benefits attendant from specialising in comparative advantage industries, while providing support to facilitate structural adjustment and ensure that the benefits from structural change are widely shared. The tools recommended are in turn based on strategies that can be (and often have been) implemented by governments subject to the usual political, informational and capacity constraints.

An early and enduring insight of economics is that international trade tends to improve an economy's aggregate income. This result follows in large part from the reallocation of factors of production from less to more efficient activities. But the implied structural changes may be far from simple; for example, they could lead to substantial reallocation of income and the temporary unemployment of resources. Importantly from a political economy perspective, workers often need to move within and across sectors, sometimes at considerable cost, and the most vulnerable— e.g. unskilled workers and those with outdated skill sets – may bear a large part of the burden. Trade-induced structural change may facilitate economic renewal and growth, but it often comes with social costs which invites vigorous resistance.

Not only is structural change a consequence of trade, but it may also affect trade. As we have seen throughout this volume, exploiting comparative advantage needs to be at the core of the structural reform process. But comparative advantage is itself a dynamic process; as noted by Irma Adelman (2000):

> *The process leading to the acquisition of dynamic comparative advantages is complex and multifaceted. New comparative advantage is achieved through a large variety of coordinated means whose nature and magnitude change dynamically: investment in specific factors of production (the acquisition of special skills and human capital; and the construction of plants and machinery) and in infrastructure (roads, ports, airports, electricity generation, telecommunication facilities, etc.); the creation of an enabling policy environment which restructures incentive systems; the building of institutions…; and through technology policy. This implies that comparative advantage is man-made, not God-given. Strategic approaches to the development of dynamic comparative advantage requires a dynamically changing, anticipatory, thrust of policy initiatives.*

Governments often play a role in helping an economy realize its potential via specialization in comparative advantage industries. As we argue below and indeed throughout this volume, this is usually best accomplished not by "picking winners," but by policies that improve the quality of factors of production and facilitate adjustment. Indeed, like all things "man-made", government action, particularly targeted trade policies such as those that focus on a specific economic activity or sector, may actually work to the detriment of long-term productivity growth and economic welfare.

Thus, there is an important two-way relationship between trade and structural change. Moreover, this relationship is important for economic, political-economic, and social reasons. In this chapter, we attempt to provide a theoretical and practical framework for developing complementary policies in facilitating trade and structural adjustment. The goal is a forward-looking perspective on policies that promote comparative-advantage-based trade and smooth the structural changes that inevitably accompany trade in a dynamic global economy. This chapter argues that such a policy mix is essential for maximizing the benefits of economic openness in the on-going process of globalisation.

Comparative advantage and structural change

Trade promotes production efficiency through, *inter alia*, specialization, cheaper and a greater variety of productive inputs and consumer goods, and technology transfer. The openness of markets to competition can provide a powerful incentive for the allocation of resources toward their most productive use. Openness helps economies to compete by not only offering new opportunities for sales (i.e. exports), but also by making available to producers the widest range of inputs at the highest quality and lowest prices (see e.g. Chapter 7). According to the World Bank, in the 1990s per capita real income grew more than three times faster for those developing countries that lowered trade barriers (5.0% per year) than for other developing countries (1.4% per year).[2] And while openness to trade can lead to short-run contractionary effects on employment, it also allows for a faster recovery: An economy that is more open is also more agile and adaptable because it is less constrained by the limits of domestic demand. Singapore, which is among the most open economies in the world, is an excellent case in point. In the first quarter of 2009, the economy contracted by 9%; by the first quarter of 2010, it was expanding by 17%.

As Part I of this volume has argued, comparative advantage continues to be a key driver of international trade. Comparative advantage is being driven by traditional channels (i.e. changing endowments of factors of production) as well as policy-related channels. A major conclusion has been that comparative advantage continues to be an important determinant of international trade (see Chapters 4 and 6). Thus, structural adjustment policies that facilitate adjustment toward an economy's dynamic comparative advantage are also likely to improve its long-run competitive prospects. Policies that work against comparative advantage, however, are likely to lead to opposite results. We focus on this key point in this section.

A substantial body of experience with "export promotion" (EP) and "import substitution industrialisation" (ISI) approaches to trade policy provides contrasting examples.[3] The EP approach refers to a vector of trade- and trade-related policies that ensures that the incentives to export balance with incentives to produce for import-substitution. This can be accomplished either via an open trade regime or one that compensates for any import protection by offering incentives for export. The Singapore and Hong Kong, China experiences are consistent with the former; those of Japan and South Korea would be consistent with the latter. It should be noted, however, that with tighter rules on export-related subsidies and incentives beginning in the 1980s, the only option for an EP regime tends to be in the area of openness. In any event, the key point of EP is to create a neutral trade regime and let the economy find its own comparative advantages and facilitate structural change in the direction of efficiency. The ISI approach takes exactly the opposite track; it emphasises that developing economies need to embrace protectionism in order to break off from the dominance of "core" (developed) economies and diversify production to embrace a broad range of goods, rather than be "locked in" to the production of a few, natural-resource-based goods. Hence, EP and ISI differ in that one embraces comparative advantage whereas the other rejects it.

Economic results strongly support the EP model. Many OECD countries have long embraced EP, and developing economies, particularly in Asia, that have moved from ISI to EP have done far better than those that have retained ISI. These economies were not "locked into" the production of a few primary good products but rather industrialised beginning with the exports of labour-intensive manufactured products before working their way up to the production of more sophisticated, skill-intensive goods. Indeed, while almost all economies — developed and developing — continue to protect parts of their economies, this tends to be due to political reasons rather than confidence in some alternative model of development. The G-20 declarations, made by key developed and developing countries, clearly recognise the need for trade policies based on EP.

Embracing comparative advantage does not mean rejecting the role of policy. On the contrary, policy makers can often reduce the costs of adjustment and increase its speed by supporting efficient structural change. Japan is an excellent case in point. The government had a key role to play in the Japanese economy in the 1950s and 1960s, but its most successful policies related to what we have called in this volume "complementary policies," such as investments in gender-neutral education, training, and infrastructure (World Bank, 1993). When Japan was a labour-abundant country in these early years, it exported labour-intensive goods. As capital accumulated and its economic structure changed, so did its export mix. The approach proved to be extremely effective in ensuring full employment of factors and economic efficiency. The earlier experience of Brazil might offer an opposite example. In the 1960s and 1970s, it embraced enthusiastically ISI and did have a number of strong growth years. But ultimately the inefficiencies created by its ISI model proved counterproductive. By attempting to contradict comparative advantage by protecting capital-intensive sectors (e.g. automobiles) in this labour abundant country, it essentially favoured capital over labour and manufactures over agriculture, and the result was inefficiency, an unemployment problem, one of the worse income distributions of any large country, and a severe poverty problem. With its economic reforms in the 1980s and 1990s, Brazil too adopted an EP approach, with significant success.

Policy is especially important in the context of market failures encountered in the process of development. These may range widely from underdeveloped financial systems to lack of infrastructure and the absence of coordinated decisions in activities that depend on each other to be viable. Lin (2010) demonstrates that development theory has progressed through multiple rounds of revision in the last half century. The earliest "structuralist" theories argued that following comparative advantage might in fact lead to stagnation. It assumed that that market failures were so pervasive in the early stages of industrialization that only "big bang" approaches to stepping up the rate of investment (through international aid or borrowing) and to solving coordination problems (through planning) could lead to an economic takeoff. State intervention at all levels of the economy, therefore, was deemed necessary. This approach ultimately led to unsuccessful ISI strategies. In turn, the next round of analysis refocused attention on comparative advantage and the need to avoid rent-seeking and unproductive investments. But its prescriptions for rapid, wide-ranging liberalization also produced disappointing results in many cases. A third wave of analysis then highlighted the importance of enabling market institutions that were required to make economies operate efficiently. But this approach led to a frustrating conclusion — namely that to achieve successful outcomes, governments needed to engineer fundamental changes in many aspects of the economic environment, including in their financial and legal systems. In short, this would lead us to the conclusion that approaches to economic development need to be comprehensive.

Contemporary research — which might be viewed as the fourth generation of development economics — is aimed at finding more pragmatic and, perhaps, limited solutions. After all, many countries, including a long list of Asian economies, have achieved rapid growth without solving all institutional challenges; what lessons can be drawn from their experience? Hausmann and Rodrik (2005) proposed a "diagnostic approach" that attempts to identify the most binding constraint(s) on development and focus limited policy resources on relieving those. Duflo (2006) with a group of scholars at MIT go a step further, and attempt to subject policy recommendations to experimental assessment. Finally, Lin and Monga (2011) propose a microeconomic approach, featuring the "identification and facilitation" of industries similar to those that have proved successful in countries at roughly twice an economy's current income level. Of course, such an approach is controversial and loaded with potential problems, particularly given the rapidly-changing global economy that suggests the present may be a poor indication of the future. Moreover, it might entail "picking winners" with its associated problems. In any event, the common theme of this recent work is that to be useful, theory needs to produce relatively simple and tailored approaches to policy, which in turn can be put to scientific testing over time.

The framework that emerges from these efforts is pragmatic in intent and highlights both the importance of comparative advantage and the structural policies that are required to complement trade liberalization in the development process. Its recommendations are eclectic, ranging from efforts to identify key areas of market failure to policy experiments and "peer learning" of successful past experiences in developing institutions and infrastructure. The goal of this work is to strengthen an economy's ability to benefit from comparative advantage. The tools it recommends are in turn based on strategies that can be (and often have been) implemented by governments subject to the usual political, informational and capacity constraints.

Complementary trade and structural policies

The policy recommendations that emerge from this approach are two-fold. On one hand, it argues for wide-ranging liberalization of international trade and investment flows to take advantage of the economy's comparative advantage. On the other hand, the approach suggests policies to facilitate adjustment in labour and capital markets in order to enable resources to move smoothly to new areas of economic activity. It also suggests investments in public infrastructure — physical and institutional — that can support the shift into new areas of economic activity consistent with an economy's evolving factor endowments and factor prices.

The trade liberalization part of this policy mix creates larger markets for competitive firms and new opportunities for investment. It raises incomes in the long run through its impact on an economy's overall productivity. Importantly its benefits derive from trade generally — that is, from both exports and imports — by improving the allocation of productive factors and expanding the consumption opportunities available to households (see, for example, Chapter 7).

Unfortunately, many observers associate the need to create jobs in the short run with trade policies that are more restrictive rather than more liberal. It is indeed possible to create domestic jobs in one country by erecting barriers to imports in industries with competitive domestic firms. However, in contrast to liberalization, such policies eliminate jobs abroad, invite foreign retaliation, and ultimately reduce productivity and real incomes at home. The ISI paradigm mentioned above collapsed in large part due to a failure to recognise these fundamental problems.

As argued in OECD *et al*. (2010), appropriately designed trade liberalisation policies can create jobs domestically in the short run without eliminating jobs in foreign countries, as well as generate income gains in the long run. An important caveat is that such liberalisation needs to be timed and structured in ways that prevent excessive disruption to an economy in the adjustment process. For example, sudden, comprehensive trade liberalisation in a small country could lead to a sharp increase in imports, leading to a contraction of import-competing sectors. It may take time and investment to employ the resources released by these sectors in others in which the economy has comparative advantage. Thus, excessively rapid reform could lead an economy to perform under capacity for a considerable period of time, with the duration depending on the flexibility of the economy. Stiglitz (2002) emphasises the need to create a "comfort zone," in which policy makers can be reasonably certain that the destruction of jobs due to trade liberalisation is less than the creation of new employment. Thus, the timing of reform needs to be appropriate and accompanying policies facilitating structural adjustment need to be in place.

When in the economic cycle should reforms be implemented? Stiglitz's approach would suggest that it should be done when the economy is reasonably close to full employment—then the gradual processes of job creation in the economy will absorb any temporary job dislocations from trade reform. But if the economy is not "broke", can the political system be mobilized to "fix it"? And if the economy is broke (i.e. in recession), a unilateral trade liberalization program may not meet the requirements of Stiglitz's comfort zone.

Even if unilateral trade liberalisation by a country were to affect its employment negatively in the short run – which is not necessarily the case – it will be always possible to design coordinated policies in several countries that generate positive results for all, from an economic perspective. The interesting implication is that while countries have incentives to liberalise independently under favourable economic conditions – that is, when they are within their comfort zones due to high employment levels – they may need to coordinate liberalisation policies when they face unemployment. However, unemployment may make each country reluctant to liberalize exactly when liberalization (and especially the avoidance of protectionism) is most urgently needed for reducing unemployment everywhere. Trade cooperation, a central goal of the WTO framework, is an especially high priority in periods of crisis such as those under the global recession of 2008-2009.

Regardless of when and how trade liberalization is implemented, complementary structural measures that facilitate adjustment can make it more effective and less costly. These policies could include a wide variety of possibilities, such as labour market policies that provide pecuniary benefits to compensate for job loss stemming from trade, educational and other training programs to integrate workers into expanding sectors, information exchanges that facilitate the matching of job seekers with job opening, and so on. They could include policies that provide support for trade finance, especially for smaller companies that tend to be most impacted by financial constraints in periods of change. In addition to having a strong equity and efficiency component to them, such complementary policies may help to ensure the social sustainability of reforms.

In times of unemployment, the jobs created by liberalization will be amplified by income multipliers. The multipliers associated with liberalisation are likely to be much larger than those associated with government spending, because demand created by liberalisation represents a permanent increase in welfare; it does not create public debt and hence does not induce precautionary saving.[4] The multipliers will be especially large if several major economies adopt concerted liberalization policies together. Moreover, in contrast to conventional fiscal stimulus measures, the benefits associated with employment generated by liberalization do not fade away as an economy returns to full employment. At that point, of course the employment-generating effects of liberalization become less relevant. But the benefits of liberalization do not disappear; rather, they show up in the more usual form of raising the productivity of the world economy and thus rising real incomes.

Trade liberalization strategies

The broad case for liberalisation holds regardless of whether other countries also liberalise. Still, a group of economies can be better off by liberalising together, that is, via concerted unilateral liberalisation. Liberalisation enhances the efficiency and competitiveness of an economy by creating an environment in which it exploits its comparative advantage. But the degree of protection in other economies also matters. For example, if a country has inherent comparative advantage in agricultural products, the market access provided by other countries for its agricultural exports will affect the degree to which it can specialise and improve its terms of trade, and thus benefit from its liberalisation program. Comparative advantage is dictated by international relative prices; therefore, the protective structure in foreign countries is relevant to the potential for exploiting comparative advantage.

Thus, countries have a strong incentive to cooperate in reducing barriers to economic interchange at many levels, including multilateral and regional/bilateral levels, as well as in concerted fashion. Below, we consider several alternative approaches to further liberalisation, that is, multilateral cooperation; regional co-operation; and means to pursue concerted liberalisation.

Multilateral co-operation

From an efficiency viewpoint, multilateral liberalisation on a most-favoured-nation (MFN) basis tends to yield the best outcome from a global perspective and from the perspective of individual economies.[5] Yet this can be difficult to achieve. The Doha Development Agenda (DDA) negotiations began in November 2001 and, as of the time of our writing a decade later, a successful agreement has not yet been forthcoming. Negotiators will not be able to reach the comprehensive "single-undertaking" that they had set out to achieve in the near term, but there has been talk of alternative deliverables (e.g. on trade facilitation, tariff-free/quota-free access to WTO member markets for least-developed economies) or "early harvests" by the end of 2011. These, too, are proving elusive.

Such a modest (if any) "success" is disappointing after so many years of negotiation, particularly since the DDA began essentially when regional trading agreements (RTAs), which we define for simplicity to include bilateral and plurilateral accords, began to flourish. At the same time little has happened at the multilateral level, the number of RTAs, including both goods and services, notified to the WTO has ballooned to 489 (as of 15 May 2011[6]). Now, *ceteris paribus*, MFN-based agreements are superior from an efficiency point of view because they do not give preferences across countries, whereas RTAs do (as discussed below). On the other hand, RTAs tend to be more symmetric in terms of coverage and level of protection (Plummer, 2007); according to Article XXIV of the WTO, for example, coverage should be essentially all goods and the level of protection should be at zero. GATT/WTO rounds in the past have yielded a great deal of asymmetry in terms of level of protection and are less comprehensive, at least in the case of the more modern RTAs. In theory, discrimination across goods and services in an unbalanced, weak "Doha-Lite" accord could generate more deleterious economic effects than discrimination across countries.

In sum, it is easy to make a strong economic case for an ambitious, comprehensive DDA, but political realities have prevented such an accord in the form of a single-undertaking from happening, at least for the time being. Selected agreements, perhaps led by the G-20, could advance the multilateral liberalization agenda by urging the conclusion of large sectoral agreements, either as part of the DDA package, or independently. Relatively early agreement may be achievable, for example, in Environmental Goods and Services (EGS), either in the WTO or in a plurilateral forum such as APEC. (The Information Technology Agreement was first agreed in APEC and then forwarded to action in the WTO.) Care has to be taken, however, to make sure that such sectoral accords will not create distortions inherent in partial approaches to trade liberalisation (e.g. by exacerbating "effective" rates of protection). And, of course, these agreements have also proven to be politically difficult to implement.[7]

RTAs

There are many factors behind the regionalism trend globally, and an extensive review is beyond the scope of this chapter, particularly since each agreement may have a different set of reasons. One important motivation for RTAs is that multilateral efforts appear to be producing little progress on updating the framework of international trade relations to requirements of the changing global business environment—including, for example, the dramatic rise of emerging economies and of services trade. RTAs may be able to produce the "deep integration" that the WTO has yet to be able to deliver. In order to facilitate the construction of production networks and profit from the process of fragmented trade, it is critical to remove as many obstacles to trade and investment as possible, and RTAs between two (or a small group) of like-minded countries is easier to achieve than in the context of the WTO. While a successful DDA would reduce the potential negative effects of regionalism (at the margin), it would not stem the growth in the RTA movement, especially in Asia, where international production networks require a "deeper"[8] integration agenda than could ever be expected to emerge out of the WTO in the medium- (or even long-) term. The economic-development strategy of Asia is predicated on outward-orientation, and the deep integration measures associated with RTAs appear to be a more effective means of advancing globalization at present.

Some countries pursue RTAs in order to avoid discrimination against their products in important markets. As noted by Jacob Viner (1951), the discriminatory nature of RTAs leads to the potential for partner countries to have an advantage over non-partner countries in terms of market access. This could lead to "trade diversion", which not only hurts non-partner countries but also is costly to the "home" country, which ends up sourcing its imports from a higher-cost country. At the turn of this century, essentially all developed countries were embracing discriminatory trading arrangement with potential trade- and investment- diverting implications for excluded countries. Europe had been implementing deeper regional initiative between its member-states and former colonies for about a half century; however, the "deepening" of integration had increased substantially in the 1990s. The United States had few preferential trading arrangements before 2000 but then bilateral RTAs became an important part of its commercial policy in subsequent years and continues to be a major force today. This consideration becomes more important as globalization continues apace (and multilateral cooperation continues to be stalled).

While some economists support RTAs due to their generally positive trade and investment effects, the second-best nature of RTAs has led others to question their economic effects, especially with respect to the potential diversion effects of rules of origin. The debate over the pros and cons of RTAs is not likely to be resolved soon. However, most economists do agree that RTAs should be as consistent with non-discrimination and "best trade practices" – as expressed for example in Article XXIV of GATT – as far as possible.[9] RTAs are generally strongly supported by the private sector, and that offers some assurance that they reduce the costs of doing business and barriers to international trade.

Concerted liberalisation

Still another approach — often described as "concerted liberalization" or "open regionalism" — combines the non-discriminatory aspects of the WTO with the regional approach of RTAs. In this case, a group of countries agrees to remove barriers to trade and investment jointly on a non-discriminatory basis. The "Bogor Vision" of APEC, which was to create an open market for trade and investment by 2010 (2020 for developing countries), was based on this approach. The problem with such an approach is not so much in the economics as in the politics. For example, if APEC countries remove their barriers to trade on an MFN basis, the group is large enough to generate significant gains for all participating economies. In theory, this should be enough to induce them to adopt the concerted liberalization policy. But the policy would also produce benefits for non-member countries without their having to contribute. This will be difficult to sell to politicians in member countries, who would like all potential beneficiaries to "pay" for their benefits. Not surprisingly, the Bogor Vision has been difficult to implement, and even APEC has endorsed a "Free-Trade area of the Asia-Pacific," which is generally envisioned as an RTA.

Structural change strategies

The second dimension of a welfare-increasing policy mix consists of structural policies that enhance an economy's ability to exploit comparative advantage. These policies, along with trade liberalisation, may create new opportunities for profit and generate additional demand and investment, and hence jobs (in the context of less-than-full employment economy). Broadly, they fall into two categories: (a) policies that facilitate shifting resources from old to new areas of comparative advantage, and (b) policies that raise productivity or improve factors of production in areas favoured by comparative advantage. The first group might include policies to improve labour market flexibility, while the second group could, for example, include creating a strong regulatory or research infrastructure to support bio-technology industries. Factor market reforms often facilitate both policy categories.

Improving labour markets

A critical group of structural policies affects the functioning of labour markets themselves because they generate benefits independently of other policies, and because they help to maximize the impact of all trade liberalisation strategies. People have to know about the jobs created by reform, suggesting the need for efficient and easy-to-access information channels; they have to be in the right place at the right time; and they must have the skills and incentives to fill newly opened positions.

The labour market reforms that achieve these objectives will differ widely across countries, given their diverse labour market structures, but international and regional cooperation can highlight their importance and ensure that international institutions stand ready to support national initiatives. The likely modalities of support will include analysis, capacity-building and, in the case of developing countries, development lending.

Smoothly functioning, well-developed labour markets involve at least three challenges. The first regards market flexibility. In mature economies, the relevant reforms would embrace policies that are pro-job creation by reducing the cost of labour to firms by, for example, reducing payroll taxes, easing bureaucratic impediments to employment creation, and creating unemployment benefits that allow labour markets to respond to wage signals. In developing economies, the appropriate reforms would involve safeguarding the bargaining positions of individual workers and improving working conditions (OECD, 2010b).

A second challenge is to assure smooth labour mobility across sectors and regions. Some advanced economies need to ease regulatory and financial constraints on mobility (OECD, 2010b) and improve the portability of job-related benefit such as pensions or health insurance. Some developing countries, in turn, need to eliminate or simplify legal regulations on regional and international migration. In both cases, there may be a need for long-term efforts to reduce language and cultural barriers among geographical regions.

A third challenge is to match the supply of skills with demand. This is true even in countries with generally high educational standards. Periods of reform, rapid technological change, and large transformations of the global economy can dramatically change the distribution of jobs and their skill requirements, and it is challenging for any economy to keep pace with the changing profile of human capital need. Thus, steady efforts to offer retraining and technological upgrading are needed even for people with considerable formal education.

Improving capital markets

The capabilities of capital markets vary greatly across countries, but many face common challenges associated with the internal logic of finance. The core imperfection of capital markets is the asymmetry of information between borrowers and lenders. Most sophisticated financial systems have developed institutions to address this challenge – ranging from relationship-based systems to specialized financial information providers. In developing countries, however, the range of financial markets and institutions is much more limited, and often credit fails to reach important classes of borrowers.

Even in sophisticated economies, some types of firms – typically those in new, small-scale, innovative sectors – find it difficult to obtain capital, particularly in times of financial stress. This limits the flow of resources across sectors and regions, especially in times of rapid change such as trade liberalization or exchange rate adjustment. Countries often provided subsidized capital to exporting firms in the past, especially in managing such periods of change, but WTO disciplines now prohibit such interventions. The challenge today is to monitor financial access, especially in periods of stress or change, to ensure that information-sharing and insurance mechanisms exist, and to provide firms with technical assistance in navigating these complicated markets. Moreover, the need to ensure adequate trade finance, particularly for developing economies, in times of stress has become a priority for multilateral and regional development banks in the wake of the 2008-2009 crisis.

Infrastructure

Lin (2010) argues that appropriate infrastructure development is essential for exploiting comparative advantage at certain stages of development. For example, good access to electric power, ports and roads is essential for building large-scale, efficient metal-working and construction industries. In Korea, ports developed in part for the military efforts associated with the Korean War played an important role in laying the foundations of a leading shipbuilding industry. There are important unmet needs for physical infrastructure in virtually all developing economies and some developed ones, as analyzed, for example, in Hallaert *et al*. (2011).[10] At the same time, institutional infrastructure is essential for advanced, knowledge-based industries. Education, good communications systems and intellectual property protection are key elements of the infrastructure required for success in telecommunications services and business process outsourcing.

Service sector reform

The share of services in value added and employment is large and rising in most economies, yet productivity levels remain more widely dispersed than in the production of goods. Services tend to be labour-intensive, employment-generating, and until recently, difficult to trade. But liberalisation of services trade is complicated, as policy barriers tend to be "behind-the-border" and, therefore, more difficult to address in bilateral and multilateral forums. Moreover, service industries are often protected by more significant natural barriers than international production sectors, which is why many services categories are even characterised as "non-tradeable." The continued reduction of policy barriers and, where possible, natural barriers represents a major source of potential productivity gains, facilitated by innovations in information technology. International support for service sector reform – through analysis, capacity building and, as appropriate, development lending – is well justified. Such efforts would usefully complement the liberalization of trade and investment in services.

Conclusions

The framework that emerges from these efforts is pragmatic in intent and highlights the structural policies that are required to complement trade liberalization in the development process within the context of comparative advantage. Its recommendations are eclectic – ranging from efforts to identify key areas of market failure to policy experiments to ideas on how to frame the broad context within which trade takes place. The goal of this work is to strengthen an economy's ability to maximise benefits attendant from specialising in comparative advantage industries, while providing support to facilitate structural adjustment and ensure that the benefits from structural change are widely shared. The tools it recommends are in turn based on strategies that can be (and often have been) implemented by governments subject to the usual political, informational and capacity constraints.

We have noted that there is a strong economic incentive for countries to engage in economic reform on a concerted basis, for both economic and political reasons. The first-best solution is likely to be a successful conclusion to an ambitious, deep DDA package, complemented by outward-oriented RTAs based on best practices and other forms of concerted liberalisation. Should the former prove to be impossible to achieve in the short-medium term, then a focus on the latter forms of co-operation would be appropriate.

Included in this vector of concerted initiatives would be the G-20, which has emerged as an institution that is well-placed at the centre of global efforts to promote "strong, balanced, sustainable growth" through structural measures. The task of replacing the current short-term macroeconomic interventions – which will have to be exited – with an effective medium-term structural agenda represents the G-20's greatest challenge in the months ahead. Certainly, trade policy should be an important part of this agenda.

This shift will require the G-20 to address more complex policy options and implementation modalities than were needed for handling short-term macroeconomic issues. It will also require new partnerships between the G-20 and international organizations to bridge the gap between global objectives and the varied national policies that are needed to implement a structural agenda. International institutions, such as the OECD, can help the G-20 operationalise its policy objectives, focusing on structural policies linked to their long-standing areas of expertise.

Coordination might take the form of a "scissors" approach, with simultaneous steps by the G-20 and the international organizations to converge on effective collaborative strategies. On one hand, the G-20 might set priorities and principles for implementing structural reform, and on the other, international organizations might propose solutions – together or possibly even in competition with each other – for assessment and alignment with global priorities.

The global economy has changed almost beyond recognition over the past quarter-century; while reading tea leaves holds perils, it would appear that this dynamic transformation will continue. Governments need to be responsive by keeping up with markets and creating a facilitating environment for structural change based on comparative advantage. Hopefully, the above analysis sheds some light on which policies government might embrace to this end, as well as those that should be eschewed.

Notes

1. Peter A. Petri, Dean, International Business School, Brandeis University, United States, and Michael G. Plummer, Head of Development Division, Trade and Agriculture Directorate, OECD. The views expressed are those of the authors alone and are not meant to represent the views of the OECD or any of its members.

2. As cited in OECD, 2010, "Why Open Markets Matter," *www.oecd.org/document/24/0,3746,en_2649_37431_45274200_1_1_1_37431,00.html* .

3. We might identify the policy experiences of Asia with the former and Latin American with this latter. Such attribution is, of course, simplistic: there were many Asian economies that embraced ISI at some point, and many Latin American economies have embraced EP. Still, at key points in their industrialisation/development paths we might argue that Asian chose EP and Latin America ISI.

4. Government expenditures that result in public debt are likely to have offsetting savings effects as households anticipate future tax increases (in technical terms, "Ricardian equivalence"). Thus, the multiplier effects of liberalisation will be larger than those of deficit-financed government expenditures.

5. From an individual country point of view, in theory there are three reasons why global free trade may not be best, that is: (1) in the case of a large country, in which the country can use tariffs to affect terms of trade to its advantage (the "optimal tariff" argument); (2) for developing countries, in which financial bottlenecks and "learning by doing" externalities may create the incentive to have in place (temporary) tariffs to protect "infant industries"; and (3) "strategic trade policies," which, in the context of a large developed country in which there is imperfect competition, trade policy can be used to shift profits from foreign to domestic firms. While theoretically possible, in practice these arguments all have problems. For example, countries do not systematically use tariffs merely to manipulate terms of trade to their advantage, which, among many other problems, would invite retaliation; picking what is truly an "infant industry" is very difficult, and removing protective tariffs to allow them to "grow up" tends to be difficult politically; and "strategic trade policy" is difficult to devise even in theory and such an explicit approach to trade would certain lead to retaliation.

6. WTO, *www.wto.org/english/tratop_e/region_e/region_e.htm*, accessed 10 June 2011.

7. For example, the APEC "Early Voluntary Sectoral Liberalisation", proposed in the wake of the successful Information Technology Agreement, ended in failure. Moreover, the "alterative" packages proposed during the spring and summer of 2011 for the WTO Ministerial in December 2011 have not yet borne fruit.

8. Consistent with the literature, by "deeper" here we refer to policies that go beyond traditional tariff barriers to include policies such as various non-tariff barriers, services barriers, customs reforms, and other behind-the-border measures.

9. See, for example, Plummer (2007).

10. This work underscores that infrastructure, in particular electricity, constitutes a key binding constraint on international trade.

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