Innovation and the Development Agenda

Edited by Erika Kraemer-Mbula and Watu Wamae

OECD *Innovation Strategy*

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Foreword

Innovation in developing economies is a means of wealth and job creation and of economic growth. However, this innovation may be managed quite differently from technological innovation, which is based in developed and emerging economies on the formal creation of knowledge through research and development (R&D). Non-technological innovation and the use of existing knowledge to create value in the marketplace are more likely to be found in the developing world, where these activities are not tracked as part of official statistics.

In January 2009, an OECD-UNESCO workshop was held on Innovation for Development: Converting Knowledge to Value. It examined the role of knowledge in innovation, its place in innovation systems and in innovation strategies, and ways of supporting North-South knowledge flows. It gave rise to a wide-ranging discussion which made the point that case studies, country reports, official surveys, analysis and informed discussion were needed to improve innovation activities and their connections locally and globally in order to create more value and allow countries to innovate out of poverty. A recurring observation was that innovation is frequently driven by entrepreneurs who work in the informal economy, where there is significant economic activity. A key conclusion emerging from the discussions was that there will be too little innovation and entrepreneurship in developing countries in the absence of major public support through institutions, policies and programmes, and services. It is therefore of strategic importance to get innovation, wherever it occurs, onto the development agenda and into public policy and programming.

In April 2009, an expert meeting, Innovating Out of Poverty, was held, by the OECD Development Co-operation Directorate (DCD). Discussion ranged from promoting the neglected agriculture sector as a knowledge-based industry connected to other parts of the economy through information and communication technologies (ICTs) to creating a new industry by importing silk production methods from India to Rwanda, to more productive ways of growing rice. As in the earlier workshop, there was a call for more case studies on innovation activities and for analysis and sharing of this knowledge in the developing world. It was recognised that much innovation consisted of problem solving by entrepreneurs who use their local knowledge and that it is necessary to understand and support this.

The workshops shared a common set of background papers and were designed to contribute to ongoing work at the OECD, especially to the Innovation Strategy. Innovation, and strategies for its promotion, are not prerogatives of OECD member countries but global activities. Not only do they contribute to the creation of wealth and economic growth but they can mitigate the effects of climate change, contribute to disease control and improve resource management. This publication provides an introduction to innovation in developing countries and supports the case for putting innovation on the development agenda. The volume is edited by Erika Kraemer-Mbula and Watu Wamae.

Andrew Wyckoff
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Directorate for Science, Technology
and Industry (DSTI)

Richard Carey
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Directorate (DCD)

Acknowledgements

Many people were involved in the two meetings that were the basis for this volume, and it is possible to mention only a few. The January 2009 Workshop, Innovation for Development: Converting Knowledge to Value, was a joint OECD-UNESCO meeting. Pier Carlo Padoan, Deputy Secretary General and Chief Economist of the OECD, and Walter Erdelen, then Assistant Director-General for Natural Sciences at UNESCO, provided clear direction and the expectations of their respective organisations for the outcomes of the meeting. The meeting was organised by Gang Zhang from the Directorate for Science, Technology and Industry (DSTI), OECD; Tony Marjoram from the Basic and Engineering Sciences Division of UNESCO; and Fred Gault and Jean Woo, then from the Canadian International Development Research Centre (IDRC). Funding was provided by the IDRC, the OECD and UNESCO and, through support to UNESCO, the Swedish International Development Co-operation Agency (Sida).

Susanne Huttner, then Director of DSTI, supported the workshop, and the OECD commissioned four background papers which served as inputs to both the workshop and the expert meeting in April 2009. Revised versions of three of these papers can be found in Chapters 5, 6 and 7 of this publication. The IDRC commissioned the preparation of the Rapporteur's Report which was included in the Workshop Summary published by UNESCO, and three reports are included in this publication as Chapters 2, 3 and 4, with additional material from a fourth OECD background paper. The book is an OECD-IDRC joint publication and the work was carried out with the aid of a grant from the IDRC.

The expert meeting, Innovating Out of Poverty, was initiated by Richard Carey, then Director of the Development Co-operation Directorate (DCD) of the OECD, with funding and support from the Government of Japan. Management of the meeting was provided by Kaori Miyamoto with colleagues from DCD, in co-operation with DSTI and the OECD Trade and Agriculture Directorate (TAD).

The chairperson of the expert meeting, Calestous Juma, produced a Chairman's Summary following the meeting which argued the case for treating agriculture, supported by an information and communications technology (ICT) infrastructure, as a knowledge-intensive industry. He distributed the summary to senior members of governments in Africa.

A final acknowledgement goes to all of the people from developing and developed countries, in the public and private sectors, and from international organisations such as the African Development Bank, the Consultative Group on International Agricultural Research (CGIAR), the International Federation of Agricultural Producers (IFAP), the International Fund for Agricultural Development (IFAD), the UK Royal Society, the UN Conference on Trade and Development (UNCTAD), and the World Bank, that made these two meetings seminal events.

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Executive Summary

Innovation can drive growth and create jobs. It happens in the least developed countries as well as in the most developed. In all countries, benefits can be reaped by well-planned policy interventions to support innovation, but this is neither simple nor easy, and no one approach suits all. Innovation policy has to take account of local conditions, economic inequities, demographic challenges and informal economic activity if there are to be positive outcomes. This suggests that the understanding of innovation, and of innovation policy, should have greater prominence on the development agenda, and this volume aims to help that happen.

The basis of this publication was two meetings held at the OECD in 2009 which focused on innovation in development. The first was a workshop, Innovation for Development: Converting Knowledge to Value, which was a joint OECD-UNESCO undertaking in January 2009. The second was an expert meeting, Innovating Out of Poverty, in April 2009, which was initiated by the OECD Development Co-ordination Directorate (DCD). The meetings were part of cross-cutting work on the OECD Innovation Strategy. They were held not just to make innovation prominent on the development agenda but also to ensure that development has a place in the Innovation Strategy.

Chapter 1 provides background, a summary of outcomes of the two meetings, including areas for action to be taken, and a review of work done to rise to the challenge of putting innovation on the development agenda. Chapter 2 provides the key issues emerging from the meetings and sets the stage for the chapters that follow.

Chapter 3 deals with theory and frameworks related to innovation for development, and Chapter 4 applies the innovation systems framework to Sub-Saharan Africa. Then, Chapter 5 examines the complexities of knowledge policies for development, and Chapter 6 gives concrete examples of the mechanisms that enable North-South knowledge flows and makes proposals for improving them. Chapter 7 returns to innovation strategies in developing countries and ends with a list of recommendations for policy practitioners.

Directions and challenges

Chapter 1 elaborates on the role of development in the OECD Innovation Strategy released in May 2010, on the need for more policy-relevant knowledge for development and for capacity building in the area of innovation and innovation policy, especially at a time of economic turbulence. This goes beyond policy for innovation driven by research and development (R&D) to include other sources of knowledge. It also involves the gathering of knowledge about innovation policy by working with international organisations and donors to use the OECD approach to country reviews of innovation policy in developing countries.

Actions have been initiated since the meetings. These include putting innovation on the agenda of the Development Assistance Committee (DAC) for the first time in over a decade, the holding of the first annual OECD Council meeting on development issues, and the elevation of development by the US Department of State to equal status with

diplomacy and defence. Germany and Japan have active development initiatives that stress the need for horizontal co-operation in achieving their agendas.

At the OECD, the Directorate for Science, Technology and Industry (DSTI) has created a new division, Country Studies and Outlook (CSO), to undertake reviews of innovation in both OECD and non-OECD countries. Since the OECD-UNESCO workshop, the Swedish International Development Co-operation Agency (Sida) has created the UNESCO Chair on Research Management and Innovation Systems and launched a new project, Innovation for International Development: Knowledge and Research Application, to address the Millennium Development Goals (MDGs). UNESCO has also launched an initiative to facilitate South-South learning through the International Science, Technology and Innovation Centre for South-South Co-operation (ISTIC).

Canada's International Development Research Centre (IDRC) is supporting case study work and training related to innovation activities through a UNU-MERIT project and graduate student field work administered by the Tshwane University of Technology Institute for Economic Research on Innovation (IERI).

The World Bank held a Global Forum on Science, Technology and Innovation Capacity Building Partnerships for Sustainable Development in December 2009. It is also developing an action plan for capacity building through partnerships with other stakeholders and international organisations.

In line with the measurement agenda of the OECD Innovation Strategy, and funded by Sida, the New Partnership for Africa's Development (NEPAD)'s Office of Science and Technology is supporting measurement activities in 19 African countries to improve the measurement and comparability of statistics on R&D and innovation.

Key issues

Chapter 2 focuses on the key issues considered in the rest of the volume and on those which came out of the two meetings. They include innovation as a driver for development; learning as a basis for innovation and for innovation policy; innovation systems as a tool for understanding innovation; the role of innovation policy and policy learning; and the need to adapt the innovation systems framework to the context of Africa.

A framework for understanding innovation has to take account of the instability, the inequalities and the heterogeneities present when innovation takes place in a developing environment. The cross-cutting nature of innovation, which is underlined by the OECD Innovation Strategy, requires coherence among the policies that are expected to influence innovation and these should be directed at or generated from the local level. Learning is a key aspect of innovation and institutions of learning may need better connections with firms, governments and other institutions of learning for there to be stronger support for innovation. The knowledge that contributes to innovation can result from learning by doing, using and interacting, from indigenous knowledge, from the experience gained in the informal economy and from knowledge gained through formal R&D.

Challenges for applying the innovation systems framework: the case of Sub-Saharan Africa

Chapter 3 reviews the innovation systems literature and its application in development as a framework for interpreting issues examined in later chapters. It introduces the discussion of knowledge sources and systems that recurs in Chapter 5 and of absorptive capacity for knowledge, as well as the role of learning at the local level and as a result of framework conditions involving institutions of education, health and government services. The chapter ends by looking at the relevance of the innovation systems perspective to policy in Sub-Saharan Africa.

Chapter 4 applies the innovation systems approach to Sub-Saharan Africa and deals with concrete issues such as the role of extractive industries, infrastructure, foreign direct investment (FDI) and learning, a subject also addressed in Chapter 6. It discusses the large informal sector and the challenges of converting knowledge to value within it. These include: the high rate of population growth and the youth of the populations of African countries, which creates a need to find jobs for young and unskilled people; the urbanisation of the population and the growth around cities of informal settlements in which the informal economy dominates; the social and economic inequities that are part of the reason for the informal economy; and the bias against women, children and migrants. There follows an explanation of how the informal sector has emerged and continues to grow, and a discussion of how it fits into an innovation system. That gives rise to consideration of demand-driven innovation, skills needed in the informal sector, the place of the informal sector in value chains, and the role of intermediary organisations and power relations.

Knowledge creation, technology transfer and innovation strategies in developing countries: Policy issues

Chapter 5 looks at knowledge institutions, develops a knowledge ecology, and relates it to an innovation system. This involves a discussion of the linkages between institutions that facilitate knowledge flows and of the discovery process that lets countries find out which areas of science and technology they are good at. As in previous chapters, heterogeneity is an issue, and a distinction is made between the higher-income developing economies that have the capacity to generate and absorb knowledge and the low-income economies that do not. The chapter's aim is to provide a conceptual framework for the design of innovation policy in developing countries.

Chapter 6 discusses the framework conditions needed to enhance North-South knowledge flows through the transfer of intellectual property, trade and FDI. These conditions include mechanisms for investing in human capital, outward-oriented trade policies and FDI policies that do not discriminate against local firms. The chapter thus notes the need for investment in education, science and technology, and R&D to enhance absorptive capacity for knowledge transfer. It calls attention to the importance of technological infrastructure, socioeconomic infrastructure and productive capacity. Appropriate framework conditions also include transparent regulation, low risk and support for entrepreneurship. Specific incentives for FDI are discussed. While Chapter 6 provides examples of topics discussed in Chapter 5, it also links to Chapter 4 and the knowledge flow aspects of innovation in Sub-Saharan Africa.

Chapter 7 moves from innovation systems to innovation strategies in developing countries and in so doing recalls many of the issues raised in the previous chapters, such as framework conditions, skilled human resources, their stock and mobility, technology platforms and knowledge flows within the system and globally. The point is made that innovation in developing countries is not always driven by R&D but by knowledge gained through learning by doing, collaboration and information networks. This is brought to bear on the discussion of innovation strategies, and the chapter provides direction for the design of innovation policies that are domestically contextualised while taking account of global connections.

Chapter 1

The Role of Innovation in the Area of Development

by

Fred Gault*
Gang Zhang

This chapter presents the principal outcomes of two meetings held at the OECD in 2009 which focused on innovation and development as part of the cross-cutting work on the OECD Innovation Strategy. The first was a workshop, Innovation for Development: Converting Knowledge to Value, which was a joint OECD-UNESCO undertaking. The second was an expert meeting, Innovating Out of Poverty, initiated by the OECD Development Co-ordination Directorate (DCD). The chapter identifies areas for action to be taken and reviews work done since the meetings to rise to the challenge of putting innovation on the development agenda.

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Background and rationale

Development and innovation

The last half-century has seen different approaches to development which have achieved varying degrees of success. The problems of poverty and inequality are growing, not diminishing, and this is making it more urgent to find solutions to these and other problems, such as climate change. Yet the world is just recovering from a major financial crisis which has been felt everywhere and which continues to influence the flow of public and private sector resources for development.

As developed countries and the OECD address these issues, some common themes are emerging. They include the need for policy coherence in dealing with development, for leadership from developing countries and for partnerships with shared risk as well as a focus on key sectors for social and economic development, such as agriculture and health, and improving the situation of women and girls. A related theme is innovation.

Innovation is about creating value from knowledge. It can mean the provision of a new good or service to the market or the finding of new ways to produce products, to organise production or to develop a market. Knowledge is the key input to innovation. It can come from a formal process, such as research and development (R&D), it can be indigenous knowledge developed over centuries of learning from the environment, or it can be local knowledge of what works and what does not. Innovation is driven by entrepreneurs who take risks and change things. Learning how to support innovation in developing countries is a challenge, but rising to the challenge will help people to create wealth and to contribute to their society.

The OECD Innovation Strategy[1]

The OECD Innovation Strategy was initiated in 2007 by the OECD Council, meeting at Ministerial level. It was to involve work on innovation as a means of addressing global challenges, on the globalisation of innovation, on evaluation of innovation policies along with country-specific analyses (*www.oecd.org/mcm2007*). The intention was to make an important contribution to improving innovation policies in OECD and non-OECD countries.

Since June 2007 the OECD has engaged in extensive cross-disciplinary work on the role of innovation in policy, the measurement of innovation and the use of the resulting indicators in monitoring and evaluation. As a result, an OECD Innovation Strategy publication series was created (OECD 2009a, 2009b, 2009c, 2009d and 2010a) to make the findings of the work widely available.

While the initial motivation for the Innovation Strategy was to deal with the opportunities provided by the opening up of new markets and the participation of new players in the global economy, the focus shifted with the arrival of the world financial crisis and the response,[2] which prompted work on innovation and growth (OECD, 2009a). The crisis has affected international trade, investment, exchange rates and donor programmes for developing countries. The need for fiscal austerity in order to pay back the money used to finance the stimulus packages may reduce budget resources for government expenditures and may have a significant impact on development assistance.

This volume is part of the work on the OECD Innovation Strategy which was approved by OECD Council, meeting at Ministerial level in May 2010 (*www.oecd.org/mcm2010*), and is a contribution to the Innovation Strategy publication series. The findings of that work (OECD, 2010b) stress the importance of innovation for growth, the need for a coherent approach to policy, recognition of the contribution of entrepreneurs, and the strengthening of mechanisms that convert knowledge to jobs and wealth. While it is recognised that innovation is more than R&D, R&D matters and must be supported. Knowledge markets are an important means of disseminating and combining knowledge, whether from formal or informal sources. The key findings are supported by analytical work that emerged from the project (OECD, 2010c). The Innovation Strategy also developed a new measurement agenda (OECD, 2010d) to:

- improve the measurement of broader innovation and its link to macroeconomic performance;
- invest in a high-quality, comprehensive data infrastructure to measure the determinants and impacts of innovation;
- recognise the role of innovation in the public sector and promote its measurement;
- promote the design of new statistical methods and interdisciplinary approaches to data collection;
- promote the measurement of innovation for social goals and of social impacts of innovation.

Pursuing this agenda in developing countries will provide indicators that can be used for monitoring and evaluating innovation strategies and for evidence-based discussion of new policies.

Insights from the OECD Innovation Strategy work can be applied in developed and developing countries, the rich and the very poor, but this requires choice and attention to the context. These issues are discussed in this volume.

Bridging innovation and development – highlights of two meetings

In the context of the OECD Innovation Strategy project and the financial crisis, two meetings to discuss innovation and development took place. The first was a workshop in January 2009, Innovation for Development: Converting Knowledge to Value, a joint OECD-UNESCO undertaking. It drew on four background papers and presentations by participants. The papers, and the rapporteur's report, served as input to an April 2009 expert meeting, Innovating Out of Poverty, initiated and managed by the Development Co-ordination Directorate (DCD) of the OECD, in co-operation with the OECD Directorate for Science, Technology and Industry (DSTI) and the OECD Trade and Agriculture Directorate (TAD). The meetings examined various aspects of innovation in developing countries. The summary findings of the first meeting were published by UNESCO (2009) and a draft summary of the second by the OECD (2009e).

The main issues for innovation as part of development which emerged from the first meeting were: the heterogeneity of developing countries, with implications for statistical measurement and policy development; the cross-cutting nature of innovation; the need for policy coherence when dealing with innovation; the importance of learning from both successful and not so successful experiences; the importance of focusing on the local level and on local entrepreneurs for innovation; better understanding of how knowledge is

developed, transferred and absorbed at the local level; and, the importance of understanding innovation through case studies, surveys and country reports. These issues are detailed in Chapter 2.

A recurring theme in both meetings was the need for case studies to provide examples of innovation in developing countries and lead to better understanding. This information could be used in the development of national surveys of innovation and in support of country reviews of innovation policy. Statistical measurement, if it is to lead to comparable results over time or across regions, has to use an agreed set of concepts and definitions. These are found in the *Oslo Manual* (OECD/Eurostat, 2005), which deals with technological and non-technological innovation, with innovation that results from organisational change or new management practices, or with market development that does not necessarily depend on the formal development of knowledge through R&D.

Gault (2010) discusses the importance and the evolution of the use of the *Oslo Manual* in developing countries. One of the reasons for the need to be able to measure incremental and non-technological innovation, which is not necessarily based on R&D, is the significant role of the informal sector in developing countries. As the informal sector does not appear in official statistics but supports much economic and social activity and job creation, case studies and learning from those who have not just survived but prospered in such an environment in developing countries would be extremely useful.

While the informal sector is important in developing countries, so is the role of government. Developing countries, especially the least developed, may not have a functioning market or all of the institutions that constitute or support an innovation system in a developed country. This makes the role of government more important for creating the appropriate framework conditions for innovation, including the provision of an independent judiciary and property rights, a functioning financial system, an adequate and affordable higher education system, an ICT infrastructure, as well as roads, ports and transport and storage services. The public sector is relatively more present in developing countries, and there is a need to understand innovation activities in that sector as well. OECD countries are also studying public-sector innovation with a view to strengthening the performance of public-sector R&D.

In the expert meeting, Innovating Out of Poverty, there was a wide-ranging discussion on the use of information and communication technologies (ICTs) in Africa for information transfer. This has led to more efficient use of markets and to the use of the mobile phone system as a means of storing and transmitting monetary value and thus bringing banking services to the unbanked. In particular, the role of women in the success of micro-finance initiatives was emphasised. There was also extensive discussion on the role of agriculture in developing economies, including the use of an ICT infrastructure to move it from subsistence to economic significance and a knowledge-intensive industry. The draft summary of the expert meeting (OECD, 2009e) emphasised the need for bold leadership by developing country leaders, including heads of state, supported by developed countries, to move subsistence agriculture to a knowledge-intensive sector. The draft summary also emphasised the need for more and better basic infrastructure and for support for entrepreneurship and private sector development.

The two meetings had some common features and some significant differences. Both looked at the characteristics of developing economies and the problems of better understanding the link between innovation and development. However, the first focused more on concepts and definitions relating to innovation and on how to gain the knowledge to support policies that would encourage the conversion of knowledge, from

whatever source, to value in a developmental context. This is reflected in the recommendations for gaining knowledge through case studies, country innovation surveys and country reviews of innovation policies which can in turn lead to recommendations for improving policies and for implementation. The second, which reflected the interests of a group of development practitioners, focused on how to make innovation happen to improve the economies of developing countries. To prompt action, the chair of the meeting, Calestous Juma, made a draft summary available to the presidents of many African countries in order to promote the development of the agricultural sector as a knowledge-based industry.

Areas for action

The discussions and the background materials of the two meetings helped to identity a number of areas for action, in order to move the innovation for development agenda forward. From strategic and institutional capacity building points of view, the following areas are important and require early attention.

Getting innovation onto the development agenda

Science, technology and innovation (STI) play an important role in social and economic development. Yet, this has not been well recognised and made part of the development agenda of both developing countries and donors. Hence, there is an urgent need to put innovation on the development agenda and in the development process and to promote co-operation between developed and developing countries to achieve this. Positive changes are beginning to occur (see the next section for examples), but greater recognition of the role of STI is needed in order to mainstream STI onto development agendas. This calls for greater evidence-based advocacy for the important role of STI, and international organisations such as the OECD, the World Bank and the like are well placed to play a facilitating role in this action area.

Improving knowledge about innovation for development

Existing knowledge about innovation for development is scarce, scattered and unsystematic compared with knowledge about innovation in developed countries. This is due to a lack of attention to the role of STI in development. Generating relevant knowledge about innovation in developing countries is a prerequisite for promoting innovation by developing country governments and international development actors. Participants in the two meetings strongly agreed on the need for more policy-relevant knowledge. Noting the difficulty and the urgency of this task, and given the diversity of developing countries both among themselves and compared to developed countries, case studies and country innovation reviews were proposed as effective means of gaining this knowledge.

Building government capacities for innovation in developing countries

Developing countries require various capacities if they are to make innovation for development happen. Among these, institutional capacities, ranging from measuring innovation, to policy analysis, and to policy formation and implementation, have high priority, as these are generally lacking. Yet, they are fundamental for ensuring the relevance and quality of the government policy formulation and implementation that serves as a starting point for building other innovation capacities, such as R&D and

technological and educational capabilities. Strengthening government capacities of relevance to innovation is therefore a priority for action.

Enhancing the horizontality of innovation for development

The OECD Innovation Strategy project has emphasised that innovation is more than science and technology or R&D and that promoting innovation requires a horizontal, whole-of-government approach. This is important for ensuring that innovation contributes to social and economic development. For donor countries, it implies that innovation policies should be taken into consideration in order to ensure that all government policies with a direct or indirect impact on development are coherent; for developing countries, it requires co-ordination between agencies and policies to ensure that the impact of innovation for development is maximised. Both donor and developing countries need to act in this area.

Joint action by international organisations and donors

International organisations and donors can play an important role in moving the innovation for development agenda forward. Given that this is a relatively new challenge for all actors concerned, international organisations and donors should join forces to overcome the constraints imposed by shortages of knowledge, capacity and resources. It was proposed at the OECD-UNESCO workshop that the OECD could conduct innovation reviews of developing countries by applying the methodology of its country reviews of innovation policy, possibly in collaboration with other international organisations such as the World Bank and UNESCO. Some donor representatives expressed interest in funding such reviews.

The above are a set of key action areas with a focus on placing innovation on the development agenda and on improving government policies and capacities for promoting innovation in developing countries, through co-operation among all actors.

Rising to the challenges

Given that innovation is important for development and that its role in a development context has yet to be fully recognised, the first challenge is to make known the importance of innovation for development agendas. Once innovation is on the development agenda, it is then necessary to understand what innovation is and see how governments can foster and support it in a development context. A related challenge is to strengthen capacities for measuring innovation in order to better inform policy makers and to facilitate evidence-based policy making.

To rise to these challenges, initiatives are being undertaken at the national, regional and international levels by organisations represented at the 2009 meetings. The following are some initiatives and activities in the areas for action identified above.

Enhancing the role of innovation for development

Following the two meetings, the OECD Development Assistance Committee (DAC) put innovation on the agenda for the first time in the past decade or so. The draft summary of the expert meeting (OECD, 2009b) was widely circulated in Africa to make the highest levels of government aware of the need to promote agriculture as a knowledge-intensive industry. The OECD and the Information for Development Program (infoDev) of the World Bank joined forces to organise a workshop on ICT for

development in November 2009 and subsequently published the proceedings (OECD, 2009f).

The revision of the "Sussex Manifesto" 40 years after it first appeared was discussed at the meetings and is an ongoing activity. This undertaking and its role in putting innovation on the development agenda are reviewed by Ely and Bell (2009). The new manifesto, *Innovation, Sustainability, Development: A New Manifesto*, was launched on 15 June 2010 (*http://anewmanifesto.org/section/manifesto-project/*).

More recently, the OECD held the first annual Council meeting on development issues, to which it invited representatives from the accession countries – Chile (now a member), Estonia, Israel, the Russian Federation and Slovenia – as well as from the five enhanced engagement countries – Brazil, China, India, Indonesia and South Africa. Member countries and invited non-member countries recommended a wide range of areas for the OECD's future work on development. These include not only traditional priority areas, such as sound economic development, food security, taxation and mobilisation of domestic resources, anti-bribery, and trade, but also climate change, innovation, education and ICTs. To deliver on this wide range of activities, the Council called upon the OECD to enhance horizontal co-operation on development across the Organisation and the relevant committees.

The meeting of Council demonstrated OECD's commitment to development as a means of fulfilling one of its key missions, the achieving of world economic prosperity by helping to ensure global economic security. From the perspective of this volume, it is significant that innovation was one of the activities for development work identified by the Council meeting.

While the OECD is making development a cross-cutting part of its agenda, OECD member-country governments are also giving renewed priority to development. For example, the US government has raised the priority of development to that of diplomacy and defence (Clinton, 2010) with a view to integrating the three activities, while building a model of development based on partnerships rather than patronage, a model that seeks positive engagement from leaders in developing countries. As it is at the OECD, innovation is part of the new US development agenda.

The United States is focusing on sectors such as agriculture and the food system. This accounts for a significant part of gross domestic product (GDP) in developing countries and was also a recommended focus at the Innovating Out of Poverty meeting. Another focus is health, and the support of women and girls in developing countries is also a US development priority. The role of women in development was a recurring theme in the discussions at the meetings that led to this publication and is addressed in the chapters that follow.

In Europe, four think tanks[3] have collaborated to review European development co-operation (European Think-Tanks Group, 2010). Their report anticipates that the Millennium Development Goals (MDGs) will "remain an essential benchmark of progress" and recognises that "achieving the MDGs and other development goals including successful management of climate change will require joined-up thinking and action across the full range of EU policies". This is referred to as Policy Coherence for Development (PCD) and it is consistent with the calls for coherence by the OECD Council and the US Department of State. Innovation is also a key component of the report. Germany is giving more support for collaboration of research groups and

innovative industry clusters in developing countries with German research groups and competence networks.

Japan's strategic promotion of science and technology diplomacy is designed to strengthen science and technology co-operation with developing countries to contribute to resolving global issues, using Japan's advanced science and technology. The issues include the environment, energy, natural disaster prevention, infectious disease control and food security. This overlaps with areas of interest identified in both of the meetings in 2009.

Improving the knowledge of innovation in developing countries

As innovation becomes recognised as part of the development agenda, the next challenge is to understand innovation in a development context and how policy can support it.

To strengthen the country-specific work which has helped improve innovation policy and performance of member countries and selected non-member countries, the OECD Directorate for Science, Technology and Industry (DSTI) has set up a Country Studies and Outlook (CSO) division.[4] Reviews of innovation policy in developing countries (OECD 2007a, 2007b and 2008a) have served as an effective way to help them to form and implement strategies for moving towards innovation-based economies. Using the principles arising from the OECD Innovation Strategy and applying them to conditions in developing countries, the CSO is in the process of carrying out a regional review of innovation in Southeast Asia (Cambodia, Indonesia, Laos, Malaysia, Singapore, Thailand and Vietnam). It is also likely to carry out an innovation policy review on Vietnam jointly with the World Bank and a review on Peru jointly with the Inter-American Development Bank. It is also engaged in and contributing to the S&T and innovation reforms of Tanzania supported by UNESCO.

Since the January 2009 OECD-UNESCO workshop, the Secretariat for Research Co-operation (FORSKSEK) of the Swedish International Development Co-operation Agency (Sida) adjusted and enhanced its programmes in support of innovation in developing countries. Sida's recent initiatives include the creation of the UNESCO Chair on Research Management and Innovation Systems, located at the Research Policy Institute of Lund University, and the launch of a new project, Innovation for International Development: Knowledge and Research Application, to address the MDGs, which is based at UNESCO.

The overall goal of the new Sida programme is to respond to, and promote, co-operation in addressing an innovation agenda for development in low-income/ developing countries, especially in Africa. The programme will focus on innovation and associated indicators, information and information sharing, with particular reference to poverty reduction, sustainable development and other MDGs, climate change mitigation and adaptation. There will be a focus on knowledge gaps and the need for research on innovation and the sharing of knowledge and experience in these fields. The programme will be implemented through a range of interlinked activities: commissioned studies on innovation and innovation management for development; organisation and support of expert meetings, working groups and global seminars; assistance to UNESCO member states in the preparation of innovation policies and strategies and facilitation of capacity building; and institutional development for the management of innovation. The UNESCO project will work closely with the UNESCO Chair and with relevant national and international agencies and organisations around the world.

Furthermore, Sida is calling for research proposals on the impact of research and innovation in developing countries, and it is carrying out a review of Sida's current programmes aimed at supporting innovation in low-income countries. These activities are designed to strengthen knowledge about these issues and to better inform Sida and the international development community on ways to improve their support programmes for innovation.

At both of the OECD meetings the emphasis on building capacity to measure, understand and influence innovation gave rise to the acceptance of two IDRC proposals dealing with innovation in selected African countries. The first, from UNU-MERIT, was to support case study work and training related to innovation activities. The second, from the Institute for Economic Research on Innovation (IERI) at the Tshwane University of Technology, was to administer support for field work by Ph.D. candidates in the field of innovation. The two projects are expected to build capacity to understand measurement of innovation and the issues it raises, as well as innovation policy and its impact.

The two IDRC-supported projects respond to the need for case studies on innovation activities, as recognised by the two meetings, as does the joint publication of this volume by IDRC and the OECD, as a means of putting innovation on the development agenda.

In the current decade, the number of converging economies (defined as countries doubling the average per capita growth rate of high-income OECD countries) has quintupled and China and India are growing at three or four times the OECD average. This has increased the importance of and scope for South-South flows and peer learning (OECD, 2010e). Indeed, this is of critical importance for closing the technological divide between converging and developing countries; sharing experience and peer learning are increasingly important channels for increasing innovation and for building up institutional capacities to support innovation in developing countries. A recent initiative to facilitate South-South learning was the launch in 2008 of the International Science, Technology and Innovation Centre for South-South Cooperation (ISTIC) under the auspices of UNESCO. Created as a follow-up to the Summit of the G77 and China in Doha in June 2005, which urged the UNESCO to develop and implement a programme for South-South co-operation in science and technology, ISTIC has organised a series of activities aimed at facilitating the sharing of policy experiences among these countries on a wide range of innovation topics.

Building measurement and analytical capabilities in developing countries

Following the two meetings held at the OECD, the World Bank organised a Global Forum on STI Capacity Building Partnerships for Sustainable Development in December 2009. A comprehensive action plan for capacity building is currently being developed by the World Bank to tackle, through partnerships with other stakeholders and international organisations, the challenge of various types of STI capacity building in developing countries.

It is commonly recognised that indicators and policy analysis are an essential basis for capacity building. The Office of Science and Technology of the New Partnership for Africa's Development (NEPAD) participated in the January 2009 workshop. Since then it has advanced work on supporting surveys to measure R&D and innovation activities in 19 African countries and is moving towards production of the *African Innovation Outlook*, a publication which will, as it evolves, provide information and analysis to African Union (AU) member countries along lines similar to the *OECD Science, Technology and Industry Outlook* (OECD, 2008b). To benefit from OECD expertise in

this area, the NEPAD Office of S&T has attended as an observer the meetings of OECD Working Party of National Experts on S&T Indicators (NESTI).

The AU is also considering the establishment of an Observatory of Science, Technology and Innovation (AOSTI) to support data gathering and analysis and to act as a repository for the science, technology and innovation strategies of African countries (NEPAD, 2007). The AOSTI has the potential to act as a single African voice in discussions of innovation and development and to provide leadership for the development of a science of innovation policy in Africa (Gault, forthcoming).

Similarly, there is a strong need to strengthen S&T statistical indicator systems and capacities in Southeast Asian developing countries. To address this need, an ASEAN NESTI, based on the model of the OECD's NESTI, was created and met for the first time in Laos in May 2010. UNESCO and the OECD were invited to participate. A representative of the ASEAN NESTI has been invited to attend the next meeting of the OECD NESTI to discuss further collaboration. In addition, the World Bank and the OECD are examining ways to assist Vietnam to build a statistical indicators system and the necessary capacities in the context of the OECD-World Bank joint innovation policy review of Vietnam mentioned above.

Addressing the horizontality of innovation for development issues

In 2002, OECD Ministers adopted "The OECD Action for a Shared Development Agenda". In this framework, the OECD has implemented a cross-cutting programme on policy coherence for development, which aims to promote greater coherence of OECD country policies that affect development directly or indirectly. The programme's most recent report identifies the building blocks for policy coherence for development, based on the lessons learned so far (OECD, 2009g) and discusses how further progress can be made. The 2010 OECD Council, meeting at Ministerial level, encouraged the OECD to work to enhance development results by seeking greater policy coherence for development and promoting dialogue and co-operation among all development partners. The Ministers also support further OECD efforts to better mainstream the development dimension of the Organisation's work, including through its ongoing development goals exercise.

The two meetings held in 2009 at the OECD were part of these cross-cutting OECD initiatives. Both contributed to the OECD Innovation Strategy, and the second was also part of the Horizontal Project on Food, Agriculture and Development. They illustrated the benefits of collaboration by OECD directorates on the important issue of bringing innovation into the development agenda as part of the Innovation Strategy.

At the national level, in light of the cross-cutting OECD initiatives, the new US development strategy aims to co-ordinate the development work taking place in Washington. Japan is also undertaking initiatives to enhance co-ordination, for example, between the development assistance agency JICA and Japan's science and technology funding agency, JST, in order to implement jointly co-operative research projects between research institutions in Japan and in developing countries. Japan is also supporting a research project carried out by the OECD Global Science Forum to identify good practices in international research co-operation between developed and developing countries.

The contribution of this volume

This publication is about innovation for development. It presents current initiatives dealing with innovation, examines innovative activities in the developing world, and makes recommendations for further work. It brings together materials, including supporting papers and summaries, from the two meetings on innovation and development and ongoing discussions on the important topic of innovation on the development agenda. It is part of the work on the OECD Innovation Strategy.

Following the recommendations of participants in the meetings, this volume seeks to help innovation take its place on the development agenda, and not just in OECD countries. Given that innovation has only recently entered the development discourse (Chaminade *et al.*, 2009, p. 360; UNCTAD, 2007; Farley *et al.*, 2007), this volume can make a contribution by promoting a better understanding of the role of innovation in development and by exploring how governments and the international development assistance community can support innovation in developing countries.

Innovation for development

The contributors to this volume discuss issues relating to innovation in developing countries and the role of innovation in development. The authors point out present inequities, measured in terms of income or well-being, across and within countries, which the creation of wealth through innovation could lessen. They note the effects of globalisation on all aspects of the economy, public and private. While money and investment flow across borders, so do knowledge and the people who embody tacit knowledge and form networks. For developing countries, globalisation presents improved opportunities to tap into the global knowledge network, but also presents the risk of a widening innovation divide if innovation is not part of the development agenda.

Compared to developed countries, where technological innovation, linked to the formal generation of knowledge through research and development, is the focus of government policy, non-R&D-based and non-technological innovation tend to play a greater role in developing countries.[5] Non-R&D-based innovation can take place by adapting existing technologies or practices, by learning by doing or by using, and as a result of the mobility of people's knowledge and skills. If governments are to support innovation activity, there is a case for policies that encourage the conversion of knowledge, however that knowledge is gained, to value and for experimentation in policy development and implementation. However, innovation, innovation policy and the implementation of innovation policy, are not easy undertakings as the following chapters demonstrate.

Innovation is a complex process and there is no universal policy for innovation

The complexity of innovation stems from the fact that it is not an isolated event. It is part of, often the result of, a longer process and a bigger picture involving education, culture and attitudes towards risk. It is also shaped by formal institutions, such as market regulation and incentives, and it depends on a stable economic and social environment with sound governance mechanisms, including the rule of law. These conditions, referred to as framework conditions for innovation in the innovation literature, are necessary for the functioning of any economy, but they are often underdeveloped or nonexistent, in developing countries. This largely explains why innovation is weak in these countries.

However, innovation, the conversion of knowledge – and not least tacit and local knowledge – to value, does take place in developing countries, and this publication examines where it happens and what can be done to support and derive benefit from it. The turbulence created by the 2008-09 economic and financial crisis gives innovation even more immediate importance as a contributor to growth, poverty reduction and social cohesion. However, as is pointed out by Chaminade *et al*. (2009), it is impossible to identify innovation policies that would apply to all developing countries. Policies able to support innovation in a developing country require the willingness of its government to experiment with policy in order to find the solution that best fits their needs. Development assistance agencies should support this type of policy learning. These issues are also addressed in Lundvall *et al*. (2009), a study that complements this one.

The book is edited by Erika Kraemer-Mbula and Watu Wamae who were engaged as experts by the OECD and IDRC for the meetings and for the production of material for this book. Chapter 2 moves from the broad issues addressed in this chapter to the key issues, most of them drawn from the two OECD meetings. Chapter 3 explores the place of innovation in development and leads to Chapter 4 which illustrates, in the case of Sub-Saharan Africa, how an innovation systems framework can be adapted for use in developing countries.

As knowledge generation, transmission and absorption are an important part of innovation systems, Chapter 5 examines knowledge eco-systems and knowledge policy for development, while Chapter 6 deals with North-South knowledge flows and how they might be enhanced. Chapter 7 concludes by presenting ways in which the role of innovation and knowledge can achieve greater importance in developing countries.

Notes

1. Material related to the Innovation Strategy can be found at: *www.oecd.org/innovation/strategy*.
2. Work on the response to the financial crisis can be found at: *www.oecd.org/innovation/crisis*.
3. The European Think-Tanks Group consists of the Overseas Development Institute in the United Kingdom, the German Development Institute, FRIDE (A European Think-Tank for Global Action) in Spain, and the European Centre for Development Policy Management in the Netherlands.
4. The CSO is also charged with producing the future editions of the *OECD Science, Technology and Industry Outlook* – one of the DSTI flagship publications – in the context of the new, globalising environment for innovation.
5. Innovation in firms that undertake no R&D is not uncommon in developed countries (OECD, 2009c), so this is not just a development issue.

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Chapter 2

Key Issues for Innovation and Development

by

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Watu Wamae

This chapter presents some of the overarching issues that emerge throughout this volume. Issues relating to the conversion of knowledge to value and its relevance for development are contemplated from various angles. One focus is innovation systems, learning and the policy implications for developing countries. Another considers a framework for the design of strategies and policies for developing countries and issues relating to heterogeneity, localisation and coherence. Still another is specific channels of knowledge acquisition and commercialisation and the competences and capacities needed for innovation among foreign and local actors.

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Introduction

Today's world is clearly on a path of continuing innovation and development. While these processes have propelled advances in certain pockets of the world's population, the unequal distribution of knowledge and technological capabilities has led to marked inequalities, not only across but also within countries. Most current social, economic and environmental challenges require creative solutions based on innovation and technological advance.

There is no unique path to innovation for development. Innovation strategies are as diverse as the challenges facing societies in different parts of the world. Some of the challenges are shared by many (such as the current financial crisis or environmental issues) while other are local. As individuals, communities and countries search for means to overcome poverty and disease and to provide sanitation, food and income generation opportunities, innovation becomes a policy concern. Innovation is not confined to developed countries. In fact, it is increasingly recognised that innovation must become a priority for developing and least developed countries, which urgently require creative and effective solutions to ensure the welfare of their people.

Key theoretical issues

Chapters 3 and 4 make detailed reference to the innovation systems literature. The innovation systems approach takes account of the context in which the exchange of knowledge, which is conducive to learning and the accumulation of capabilities, takes place. The relationship of this literature to the developing country context is discussed. These chapters deal with some key issues.

Innovation as a key driver for development

A well-established tradition has provided a solid theoretical background linking innovation activities to the progress of countries, regions and firms (Schumpeter, 1934; Gerschenkron, 1962; Kim, 1980; Rosenberg, 1982; Freeman, 1987; Fagerberg, 1988; Perez and Soete, 1988; and many more). Current theoretical debates recognise innovation as the engine for growth and as offering substantial potential for achieving developmental effects (Cassiolato *et al*., 2003; Rosenberg, 2004; Fagerberg *et al.*, 2004; Dutrénit and Dodgson, 2005; Metcalfe and Ramlogan, 2008). A growing number of studies in developing countries continues to prove the value of innovation as a driver of socioeconomic transformation and rapid progress leading to sustainable development. Developmental challenges concern both advanced and developing economies. However, it is necessary to look at innovation activities in developing and least developed countries through a different lens. The milieu in which innovative activities take place and the needs they serve affect the nature of innovation. New research in this area has thrown fresh light on the peculiarities of innovative activities in these contexts and emphasises their incremental, informal and tacit features. Further research is needed, however, to validate the results of this emerging literature and fully unpack the specific characteristics of innovation in developing countries.

Learning as the basis of innovation

Important contributors to the field of innovation have argued that deliberate learning activities are necessary for the successful accumulation of the technological capabilities that lead to innovation (Dahlman *et al*., 1985; Lall, 1992; Bell and Pavitt, 1993; Kim, 1997; and many others). This literature sees innovation as the consequence of a process of accumulation of codified and tacit knowledge. This accumulated knowledge represents "capabilities" which are path-dependent but open to change as a result of learning or the use of new knowledge. The ability to learn manifests itself at various macro and micro levels. These chapters contribute to the debates in this field and pay particular attention to bringing the concepts of learning and capabilities closer to the reality of developing countries.

Innovation systems as an important tool for understanding innovation dynamics

Over the last few decades, theories of innovation have taken into account the increasing linkages among actors involved in innovative activities. The resulting evolutionary theories of innovation systems view innovation as the outcome of complex interactions among a variety of actors (individuals, firms and organisations) within an institutional framework (*e.g.* Freeman, 1987; Lundvall, 1992; Nelson, 1993). This framework provides a holistic view of how innovation takes place; it includes the organisations engaged in innovative activities and their interactions. The innovation systems framework provides useful theoretical insights for developing countries. However, it is important to complement these with empirical analyses so as to adapt the framework to the developing country context and provide a suitable basis for designing specific innovation strategies.

Innovation systems and innovation policy

An important contribution of the innovation systems framework is its use for the design of innovation policies and programmes. In advanced economies, innovation has been an important item on the policy agenda for some years. It has recently acquired fresh impetus from the OECD Innovation Strategy.[1] Developing countries have also started seeking to increase the rate of innovation by designing effective policy mechanisms. Nonetheless, innovation policy is still at an initial stage in developing countries. The innovation systems framework provides a basis for defining specific policy options and strategies to address social and economic challenges. However, to face some of these challenges, some important features of the innovation systems framework have to be adjusted.

Adapting the innovation systems framework to the context of Africa

The innovation systems literature has been largely developed in and for advanced economies. For this reason, it has been adept at describing innovation dynamics in formal organisations, mainly those engaged in manufacturing and industrial activities. Only recently has the research community started to apply these concepts in a developing country context, notably in Africa. Most economic activities in Africa are informal, and non-manufacturing activities (such as agriculture and resource-based sectors) constitute the backbone of the economy. Further research is urgently needed in order to explore the applicability of the innovation systems framework to Africa and the routes for adapting it to the developing country context.

Key issues for innovation policy and implementation[2]

Chapters 5 to 7 look at ways of dealing with the theoretical issues raised in the two previous chapters and of putting the conversion of knowledge to value in the context of development. They take the view that economic development is a process of acquiring technological capabilities and effectively putting them to use for socioeconomic benefit. Learning is identified as the basis of the process of accumulating these technological capabilities; combined with knowledge, it provides an avenue for innovations that can solve local problems. Innovation in the context of developing countries is fundamental for responding to local needs and for accessing international markets through competitiveness. However, under current circumstances of growing integration, not all knowledge is locally available or easily acquired.

Innovation-driven development in an unsettled environment

The relation between innovation and economic development is complex and develops in an unsettled environment and on an uneven playing field. The theoretical findings corroborate the need for a framework that acknowledges instability and inequality as the context in which innovation and development take place.

First, innovation needs to be considered in the global environment of an economic recession. Instability seems to be the norm rather than the exception in the contemporary global economic environment, so that innovation strategies should take this into account. The current economic downturn inevitably affects the investment decisions of global economic actors, thereby entailing higher uncertainty and risk aversion. Macroeconomic instability can be a very influential factor in firms' decisions to invest in human capital, R&D and other inputs to innovation. However, it is at the level of the enterprise – rather than at the aggregate level – that innovative activities need to be studied. It is in firms that the discovery and identification of national competences can be examined.

Second, the global scene is characterised by growing inequality among countries, and the gap between countries' growth rates is widening. Growing divergence between low-income, medium-income and high-income countries implies the need for different approaches to promoting innovation. Chapter 5 emphasises that one size does not fit all and that different countries have challenges in terms of policies to promote innovation and technological knowledge.

Heterogeneity

The diversity of countries, regions, sectors and firms needs to be addressed, acknowledged and welcomed in order to advance thinking about innovation strategies.

- Heterogeneity needs to be tackled at the national level because development occurs differently even within economies. Innovations are not spread evenly across all sectors of the economy, firms or regions. Different patterns of innovation are thus associated with different growth paths in different parts of the economy. It is important to acknowledge that differential growth drives structural change and therefore development.
- It is important to avoid simple recipes that consider countries as homogeneous. There are particularities that prevail in developing and least developed countries (LDCs): a greater presence of traditional sectors, agriculture and an informal economy. However, the proportions of these sectors (*e.g.* the percentage of

employment in the informal economy) vary widely even across developing countries. This calls for substantially different approaches to innovation strategies, and different institutions must play their role in the innovation system. There is a need to pay attention to context, history, path dependency, cultural considerations and existing political regimes of individual countries in the process of designing innovation strategies.

- Heterogeneity is also discussed in relation to foreign direct investment (FDI) in Chapter 6, since its capacity to contribute to innovative strategies in developing countries is also highly dependent on the context, needs and local competences of the domestic economy. The examples provided in that chapter describe the highly variable effects of FDI across countries, sectors and firms.

Cross-cutting nature of innovation

Innovation is the ability to solve problems and overcome bottlenecks in developing countries. High-impact innovations in developing countries can affect areas such as health services (*e.g.* HIV and malaria), infrastructure (*e.g.* electricity and transport), and agriculture. Innovation strategies must be considered broadly, in relation to the development of human welfare, not solely in connection to industrial production.

Policy coherence

Chapter 5 distinguishes between the components of the innovation system (innovation ecology) and the linkages among these components. Both elements (components and linkages) need to be co-ordinated and reinforced within and across innovation systems. In this connection, policy actions need to be coherent with the context in which they are applied but must also be based on sound theory. As Chapter 7 indicates, innovation policies need to include other policies that are not necessarily related to technology but are related to other developmental policies, with the ultimate goal of reducing poverty and achieving sustainable development. This requires broad co-ordination across policy departments.

Achieving policy coherence is related to policy makers' ability to obtain the knowledge necessary to make good decisions in relation to innovation. To do so, they need to: first, understand the importance of committing themselves to an open innovation system, because it is impossible to forecast the long-term future direction of innovation; second, create the conditions under which innovation can flourish; and third, understand the local environment, with its explicit and unrecognised innovative activities, as well as local demand for innovation. Adequate knowledge for coherent policy making can be obtained in three main ways:

- By including all stakeholders in innovation strategies at an early stage of the design of local, effective and coherent policies.
- By going through knowledge brokers, the agents that help bridge differences between policy researchers and policy makers. Knowledge brokers, such as international organisations, researchers, consultants and science journalists, can package information obtained from research to meet the needs of policy makers in terms of appropriate time horizons. Their role is increasing in importance, especially in developing countries.

- By ensuring that policy experimentation provides feedback into the innovation system to allow the systemic learning that leads to progress. Monitoring and evaluation are crucial in this respect. The results of monitoring and evaluation exercises need to feed into innovation systems to be useful.

Learning from the experience of others

The conventional view of learning as a passive process of experience accumulation needs to be challenged, at the level both of the firm and of policy making. Learning in developing countries requires an effort and needs to be deliberate. Innovation is not simply about learning how to do something better but how to do something differently. In relation to this, studies are identified which indicate that extensive learning processes can be managed effectively to provoke and direct active learning at the level both of the firm and of designing innovation strategies.

Focus on the local level

In developing countries, innovation strategies need to focus on the local level, because local entrepreneurs and local users are those best suited to understand the needs and possibilities of innovation. This creates a major challenge for technology transfer processes. The demand side of technology and innovation needs to be stressed in addition to the conventional focus on the supply side. Identifying local demand for certain technologies is thus a crucial, albeit a difficult task. On this point, Chapter 7 emphasises that it is important to understand what innovation activities and competences exist at the local level in order to energise local entrepreneurs and institutions effectively. A focus on the local level can be crucial for identifying cost-effective solutions and innovations that are already taking place or can be shaped through joint learning with international donors.

Generation of local knowledge and knowledge transfer

Innovation strategies need to be considered in a wider perspective, not only in terms of promoting innovative activities but also in terms of creating, deepening and extending domestic capacities and competences to innovate. Developing local competences is a key issue. This means not only technical competences but also managerial and organisational competences at the firm and policy-making levels. This is essential for successful technology transfer. Skills and capabilities are crucial, but not sufficient, because of the need to learn to convert knowledge into successful innovation. Nevertheless, even when learning and knowledge conversion occurs, the translation of these capabilities into value very much depends on the existence of well-functioning markets.

One of the problems in developing countries and LDCs is that the linkages between knowledge systems and commercialisation are very weak. This hampers the conversion of local knowledge into competences and value.

In relation to the transfer of knowledge and technology, there is a need to challenge conventional views of FDI and technology transfer to better fit the context of developing countries and LDCs.

- First, conventional views of FDI and technology transfer focus on R&D and other formal mechanisms. However, unrecorded and incremental types of knowledge creation and transfer should also be considered. These are largely ignored in FDI and technology studies related to FDI and technology transfer, although they are crucial innovation mechanisms in developing economies.

- Second, North-South transfer of knowledge is important but it is urgent to expand views on knowledge flows to include the growing importance of South–South (especially for non-high-technology innovations because they share similar needs) and South-North knowledge flows (subsidiaries in some developing countries increasingly contribute to the knowledge networks of their parent companies in the North). Even in the few cases where South-South and South-North knowledge flows have been studied, the evidence is limited to emerging and transition economies. More work is needed on other developing countries and LDCs.
- Third, the huge contribution of knowledge transfer in non-manufacturing sectors (*e.g.* health, agriculture, and the extractive, utilities and services industries) is greatly underestimated. It is crucial to include these sectors in innovation strategy design exercises. For LDCs the contribution of these non-manufacturing sectors and services is growing at a much faster rate in terms of value added than that of the manufacturing sector. As these sectors are very different from manufacturing, innovation policy and strategy issues are likely to be correspondently different.

Conclusion

This volume outlines the significant role that innovation can and does play in the arduous path of development. Making use of recent theoretical contributions to the field of innovation studies, the chapters in this volume highlight the importance of learning, networking and knowledge-sharing among multiple actors. These processes are critical for developing countries and create a space for policy experimentation within an innovation systems framework. This literature has provided a number of tools for better understanding the processes of innovation and technology development and the diversity of agents that generate, assimilate and exchange the knowledge conducive to successful innovation. Acknowledging these contributions, this volume also advances the research agenda by raising important new questions with respect to conventional approaches to innovation policy. It suggests that contributions from the innovation systems literature cannot be mechanically adopted by poorer countries whose development challenges differ from those that gave rise to these theories. Overcoming these challenges implies creative responses from the research community in devoting efforts to unexplored areas that are critical for developing countries. These include: how to support innovation in extractive industries and the informal sector, how to expand and improve the measurement of innovation, how to develop more effective ways of combining foreign and local knowledge, and how to learn from the experience of others.

Notes

1. Material related to the innovation strategy can be found at: *www.oecd.org/innovation/strategy*.
2. Much of the material in this section comes from the report from the OECD-UNESCO workshop on Innovation for Development: Converting Knowledge to Value in January 2009, Paris (Kraemer-Mbula, 2009). The content of the background papers and discussions and presentations at the workshops helped to shape these key issues.

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Chapter 3

The Relevance of Innovation Systems to Developing Countries

by

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This chapter discusses the relevance of the innovation systems perspective to Sub-Saharan African countries. It argues that so far, the main concern has been the absorption and adoption of established practice. Efforts to adapt the innovation systems framework to reflect the realities of Sub-Saharan remain limited. In addition, it notes that little attention has been attached to deepening and expanding the specific core capabilities that are fundamental to innovation for development. The importance of addressing this issue is necessary not only to tackle existing challenges but also to orient innovation towards sustainable paths.

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Introduction

This chapter discusses the implications of the innovation systems framework for developing countries. Some of the main issues surrounding the theoretical debate relate to the fact that the innovation systems concept originated in industrialised countries, which undertake relatively significant innovation at the technology frontier, have strong interactions among actors and relatively well-established organisations and institutions. As a result, attempts to integrate innovation systems approaches in development agendas of developing countries have focused on the formal S&T system and emphasised the importance of creating formal institutions and organisations. The main concern has been the absorption and adaptation of established practice. However, other aspects that are important in developing countries have received limited attention. For instance, learning is fundamental to the process of innovation, and the learning process is itself shaped by practical experience and the economic structure in which it occurs. Particularly in developing countries, learning is linked to the indigenous capabilities required to transform and modify knowledge to suit local conditions and the local context. This chapter discusses the importance of adapting the innovation systems framework in ways that take into account the structural specificities of developing countries.

Applying the innovation systems concept to developing countries

Development and innovation

Earlier contributions to development thinking identified development with economic growth and industrialisation. Developing countries were deemed to be at an earlier stage than the more advanced economies along the linear path of historical progress. This notion implied that countries pass through similar historical stages of economic development (Gerschenkron, 1962; Rostow, 1960). The central argument that emerged from this literature was that differences in development stages could be explained by differing rates in the adoption of technology (Kaldor, 1957). The underlying idea was that investment and learning were interrelated and that the rate at which they took place determined technological progress. Gerschenkron (1962), who studied international aspects of the process of innovation and learning, pioneered the idea that technology gaps between technology frontier economies and laggards provide the latter with great opportunities to acquire technology through assimilation of the existing backlog of knowledge.

It was not until the 1970s that the technology gap perspective was revisited (*e.g.* by Gomulka, 1971; Cornwall, 1977; Maddison, 1979; and Abramovitz, 1979) and led to the so-called "technology gap" literature which has widely explored the catching-up process in lagging countries. The main hypotheses are that: technology growth rates have a positive impact on economic growth rates; lagging economies may exploit the backlog of existing knowledge through a catching-up process that allows them to approach the technology frontier; and the absorptive capacity determines a lagging country's ability to embark on a successful catching-up process; it largely depends on direct government intervention, particularly by steering resources to the most technologically progressive sectors of the economy (Fagerberg,1987; Abramovitz, 1986, 1994). Fagerberg (1988) elaborated an interesting technology gap model of economic growth *per se*.

Early studies on catching up suggested that technological shortcuts exist and could allow developing countries to reach the stage of development of advanced economies. This would be achieved mainly by assimilating and adapting mature technologies (Utterback and Abernathy, 1975; Kim, 1980, 1997). In fact, some considered underdevelopment a potential advantage by giving developing countries the chance to distil valuable lessons from the experiences of industrialised nations and "leapfrog" to more efficient developmental stages. However, as Perez and Soete (1988, p. 476) remarked, this view of catching-up was a "matter of relative speed in a race along a fixed track, and technology was understood as a cumulative unidirectional process".

The technology gap literature also stressed the role of investments in science and technology (S&T), thereby highlighting the role of government in determining the speed and orienting the direction of technological change. The original Sussex Manifesto (Singer *et al.*, 1970) and many research contributions in developing countries led to a stream of policy recommendations directed to promoting scientific and technological outputs – scientific research and development (R&D), technical manpower, patents and scientific publications (Tassey, 1997; Patel, 1995; Furman *et al.*, 2002).[1] At the time, theoretical contributions implied a linear process of technological development, driven by the supply of R&D resources and other technical inputs that would sequentially translate into "better" innovations and ultimately economic growth and development. For example, Kim and Dahlman (1992) referred to three stages of technology acquisition in a developing economy: in the early stage, economies acquire mature foreign technologies that essentially involve assembly operations; the second stage is the consolidation of technology through duplicative imitation followed by creative imitation, which relies on enhanced local technological capabilities and infrastructure; the final stage involves generation of emerging technologies through investment in R&D.

The concept of innovation systems[2] was pioneered and elaborated within a framework of evolutionary technical change by Nelson and Winter (1982), Rosenberg (1982) and Freeman (1987), among others. It places technology and innovation at the centre of development and pays particular attention to the history and institutions that shape the interactions of actors in a system that is conducive to innovation (Dosi *et al.*, 1988).[3] Within this framework, innovation is viewed as a process of interactive learning in which actors improve their competences, and in so doing contribute to the conversion of knowledge to value for the socioeconomic benefit of society. Research in developing regions has made it possible to amplify and expand this view and to provide new directions for development, particularly through policy (Lall and Teubal, 1998; Nelson and Pack, 1999; Metcalfe, 2000; Chang, 2002). Despite the wide acceptance of the innovation systems approach, policy decisions still largely tend to rely on the S&T approach.[4] The operational implementation of the innovation systems approach in policy making remains a major challenge.

Discussions of development have gradually moved away from a narrow perception of development as economic growth to the idea of development as a process of social transformation. Accordingly, shaping the pattern of growth requires greater appreciation of the need for policies that directly address poverty, equity and social development. Recent views on development see it as a process of structural change which involves fundamental and interrelated changes in technology, organisation, institutions and culture. In particular, Amartya Sen (1993, 1999) focuses on human development and formulates development in terms of freedom, entitlement and capability. He argues that a focus on income and capital accumulation may be necessary but that it is not sufficient to achieve development. He places capabilities at the heart of development; they are the means to

address social development issues, such as gender, deprivation, hunger, basic needs and environment.[5] However, his view of capabilities does not make explicit reference to the link between capabilities and innovation (Johnson *et al.*, 2003).

The current debate on innovation and development are of particular relevance to Africa, and the contextualisation of these theories becomes imperative in order to provide tailored solutions that respond to African needs.

A brief presentation of the innovation systems concept

This section provides basic definitions of key innovation systems concepts in the context of development.

What is innovation?

Innovation is the process of converting new or existing knowledge to value for the benefit of individuals, groups or communities.[6] Innovation is a technical process as well as a social and economic one, which leads to a product or process (Edquist, 1997; Lundvall, 1992; Johnson *et al*., 2003). Innovation activities may result in a new or better product (or a product variety) which is offered for consumption. The product may be a new (material) good or a new (intangible) service. An innovation may also result in a new process or way of producing goods and services. A new or improved process may be material (a technological process) or intangible (an organisational process). The *Oslo Manual* defines innovation as "the implementation of a new or significantly improved product (good or service), or process, a new marketing method, or a new organisational method in business practices, workplace organisation or external relations" (OECD/Eurostat, 2005, p. 46).

In current theoretical work, innovation is recognised as an engine of growth which offers substantial potential for achieving developmental effects (Cassiolato *et al.*, 2003; Rosenberg, 2004; Fagerberg *et al*., 2004; Dutrénit and Dodgson, 2005; Metcalfe and Ramlogan, 2008). It therefore, offers opportunities to directly address poverty, inequality and environmental sustainability.

What is an innovation system?

An innovation system is a network in which actors interact and exchange both codified and tacit knowledge to undertake innovative activities. Knowledge is the key commodity in an innovation system and a network provides channels through which knowledge flows. Such a system is based on complex relationships that involve learning, a fundamental process in innovation. Many actors (such as firms, suppliers, customers, and education and financial institutions) interact in a specific environment that is shaped by history, culture and social relations. The resulting dynamics characterise a specific innovation system.

Ideally, theories of innovation should be supported by empirical evidence that clarifies these relationships and the means by which they contribute to development. However, the innovation process, and in particular its systemic character, is still not well understood (Edquist, 2005). Nevertheless, the idea that innovation occurs within a "system" reflects the recognition that the conversion of knowledge to value is shaped by structural, institutional and social factors.

What are the major components of an innovation system?

The main components of an innovation system are organisations and institutions as well as the relationships that link them (Arnold and Bell, 2001; Edquist, 2001). These three elements should form a coherent whole that provides a milieu for interactive learning, which is central to innovation.

Organisations are formal structures which are consciously created and have an explicit purpose. They are players or actors. Some important innovation system organisations are firms, universities, venture capital organisations and policy-making agencies.

Institutions are sets of common habits, norms, routines, established practices, rules or laws that regulate the relations and interactions between individuals, groups and organisations. They are the "rules of the game" (North, 1990; Edquist, 1997). Institutions influence how organisations undertake innovative activities. Examples of institutions include intellectual property rights (IPR), corporate structures of governance, competition policy and labour regulations.

Linkages are the interactions that occur within and across organisations and institutions. These are knowledge-centred interactions and are based on an underlying tension of collaboration and competition among actors. They influence the nature and degree of knowledge flows through innovation systems and in so doing shape specific trajectories of specialisation and learning.

What are the different levels of systems discussed in the literature?

The concept of innovation systems was originally developed at the national level, but two main variants have emerged in the literature:

- Spatial systems, which include national innovation systems (Freeman, 1982; Nelson and Winter, 1982; Rosenberg, 1982; Lundvall, 1985) and regional innovation systems (Cooke, 1996; Malmberg and Maskell, 1997).
- Sectoral systems (Breschi and Malerba, 1997; Malerba and Orsenigo, 2002).

Other strands of the literature refer to technological systems. Examples include: "technology systems of production" (Carlsson and Stankiewicz, 1991; Carlsson and Jacobsson, 1997; Carlsson *et al.*, 2002) and "national technology systems" (Lall and Pietrobelli, 2002).

All these variants coexist and complement each other. From a "systems" perspective, innovation is regarded as "an intricate interplay between micro and macro phenomena where macro-structures condition micro-dynamics and … new macro-structures are shaped by micro-processes" (Lundvall, 2007, p. 101).

Where does the conversion of knowledge to value take place?

The innovation system framework gives firms[7] a central role in the innovation process. Research on innovation processes is based on the firm as the main unit of analysis, particularly in the sectoral approach.[8] The learning processes that occur within and between firms are crucial in shaping the direction and extent of innovation (Arnold and Bell, 2001; Bell, 2007).

It is important to understand what takes place within firms in terms of innovative activities and learning processes. Learning processes lead to the acquisition of different types of capabilities, which are required to develop innovative products and processes

(Lall, 1992; Figueiredo, 2003; Bell, 2007). However, firms innovate not in isolation but within a system. Other organisations and institutions, such as the education system, financial systems, competition policy and property rights, influence knowledge generation as well as the ability of firms to innovate.

Innovation systems and change

Innovation systems are not static. They evolve over time in response to variations in the social, economic and political environment. The innovation systems framework takes an evolutionary approach: changes in components of the system (organisation and institutions) lead to the emergence of new interactions and innovation processes. This evolutionary aspect of innovation leads to heterogeneity across sectors, regions and countries. It is therefore important to understand the different modes of innovation within the micro-structures as well as between micro- and macro-structures in order to better identify the adaptations required within institutions and organisations to support the conversion of knowledge to value. A discussion on how learning as a fundamental process of innovation takes places within these structures is provided below.

The extent to which the system is able to respond and adapt to change is a function of its vitality (Viotti, 2002). If systems are "passive" they mostly rely on external forces to initiate learning and innovation processes. Passive systems have limited ability to adapt to change and are as a result more likely to suffer from the adverse effects of change than to capture opportunities that arise. On the contrary, "active" systems tend to have clearer targets and better co-ordination for learning and developing innovations. This distinction has important implications for questions related to building up, upgrading and transforming innovation systems, especially in developing countries.

What are the implications of innovation systems and innovation practices thinking for developing countries?

Theoretical debate on innovation systems in relation to developing countries

For the most part, the innovation systems approach is based on the socioeconomic contexts of the advanced countries in which it originated. As a result, it focuses on formal organisations and institutions. The concept remains broad and is viewed as lacking a strong theoretical foundation (Lundvall *et al*., 2002). Arguably, this provides some scope for adapting the concept to different contexts, including developing country contexts, in ways that can strengthen innovation for development. However, interactions among actors in developing economies appear much weaker than in more advanced economies, and organisations and institutions are not well established. Furthermore, in contrast to advanced economies, innovative activities in developing countries occur in a socio-economic environment that is largely defined by informal arrangements. Learning in such contexts is under-researched despite its importance in innovation processes.

Focus on the formal sector

Discussions about strengthening innovation systems still focus almost exclusively on formal organisations and institutions. As a result, policy formulation is typically oriented towards fulfilling, expanding or reforming formal organisations, especially those directly engaged in generating knowledge. Therefore, much of the debate about the generation of knowledge focuses on the role of universities and public/private research institutes as major sources of the knowledge.

The focus on the formal sector in the innovation systems perspective creates an important challenge for many developing countries. These countries have highly informal institutions and organisations. Furthermore, most productive activities depend largely on knowledge that is not codified in formal research, education or training institutions. The scant attention paid to the informal sector in the innovation systems framework suggests that its significance is not acknowledged. Yet, it represents three-quarters of non-agricultural employment and over 40% of the gross national product (GNP) of many African countries (see Chapter 4). There is a strong argument for adapting the innovation systems framework as a tool for understanding innovation in a developing country context.

Recognition of the importance of informal organisations and institutions in no way suggests that adapting the innovation systems framework in ways that adequately address them would be straightforward. It is, therefore, perhaps not surprising that the large and expanding informal segments of developing countries have been neglected in discussions of innovation systems. However, as a tool for analysis, the innovation systems framework is likely to be more useful if it provides greater clarity on the relation between learning and innovation for development in less advanced economies.

Knowledge systems in developing countries

The coexistence of "traditional" or "indigenous" knowledge and "scientific" or "modern" knowledge is a typical feature of developing countries. Modern knowledge systems represent the science-based, formally organised creation and exchange of knowledge. Traditional knowledge systems are mainly rooted in local communities and knowledge is transmitted from one generation to the next. However, in the current context of rapid change literacy is critical (see Chapter 5).

Science-based activities represent a small part of the economic activities in developing regions. It is increasingly acknowledged that traditional knowledge plays an important role in the livelihood of populations in developing countries (Bell, 2006), especially in Africa. However, traditional knowledge systems are not well articulated. This makes it difficult for them to be proactive and adapt to new demands for knowledge. Furthermore, links between modern and traditional knowledge systems tend to be weak (Bell, 2007). Therefore, one of the main challenges of the innovation systems approach is to find mechanisms for strengthening the interactions that promote knowledge flows within and between traditional and modern knowledge systems. Bell (2006) argues that efforts should be directed towards articulating and integrating traditional and modern knowledge systems in an interactive process of innovation.

Transformation of innovation systems

Innovation systems are largely shaped by social, institutional and historical conditions. The transformation of innovation systems therefore depends on changes in these conditions, which are varied, multiple and interconnected. For instance, changes in population dynamics (population growth rates, urbanisation), changes in productive systems (a shift from agrarian to manufacturing and services sectors), and other factors (changes in the political regime, civil unrest, etc.) differ from country to country. These and other dynamics stimulate the transformation and evolution of innovation systems.

The transformation of often weak and fragmented innovation systems is a major challenge for developing countries. First, the components (organisations, institutions and linkages) of the system are absent in many cases; and second, improving the overall vitality of the system would require an understanding of innovation processes in the

informal sector as well as linkages between innovation processes in the formal and informal sectors.

Building effective innovation systems in Sub-Saharan Africa may require not only setting up formal organisations and institutions, but also encouraging innovation activities by systematically upgrading the competences of existing components, particularly those with identified potential. This may require identifying the bottlenecks in the system, improving knowledge flows across the system and strengthening linkages among actors. The capacity of the system to transform and adapt will determine its ability to promote successful innovation sub-systems and phase out less productive ones (Metcalfe and Ramlogan, 2006).

Innovative activities in developing countries

The literature on innovation in developing countries and particularly in low-income countries emphasises four issues (Edquist, 2001): *i)* product *versus* process innovations; *ii)* innovation in low and medium technologies; *iii)* incremental innovation; and *iv)* absorptive capacity. Each of these is discussed in turn.

Product versus *process innovations*

Product innovations are regarded as more important than process innovations. They are considered to have a greater effect on the production structure than process innovations. For instance, a new product design can allow a firm to enter a new market, while process innovations tend to ensure a market position by lowering the firm's average production cost. In addition, product innovations are employment-creating while process innovations are considered to be labour-saving. These distinctions appear to have been developed for firms operating in the manufacturing sector and inspired by the spectacular export-oriented growth observed in a number of Asian countries. Although the literature points out that process innovations should not be ignored because they offer a basis for increasing product innovations, the link between product and process innovation in Sub-Saharan Africa is under-researched.

In most cases, developing countries operate in mature industries such as food production. It has been argued that improving processes in mature industries is crucial for competitiveness. Moreover, as these industries evolve, process improvements continue to be important in paving the way for product improvement and variation.

Process innovations have modified organisational structures of production, for example in terms of stocks and delivery practices. Previously, production structures were based on limited product diversity and hierarchical labour processes targeted at economies of scale. They involved "just-in-case production", that is, they were essentially supply-driven. That mode of production has been replaced by "just-in-time" production, which requires flexible production systems driven by the diversity of demand. This is reflected in the segmented markets and rapid product differentiation that increasingly defines non-bulk production. These organisational changes have spread from manufacturing to other sectors. For example, there are a number of retail value chains for fresh agricultural products – fruits, vegetables, cut flowers, etc. Success in these value chains depends largely on the transformation of organisational processes, particularly because the products in question have a limited shelf life. It also depends on the ability to improve and adapt technological processes for food processing and storage.

The current global architecture of production is governed by global value chains. Value chains are the combination of activities of multiple firms – often distributed globally – that take a product or service from design to consumption (Kaplinsky and Morris, 2001). Innovation practices at various nodes along the chain have a direct impact on how the chain is organised and governed and determine the nature of benefits accruing to different agents (who gains what).

Firms that are shaping global value chains in agriculture have spread rapidly to developing countries. They include Tesco, Safeways, Sainsbury and Albert Heinz (Rasiah, 2008). Responding to changes in consumer behaviour in the global food market requires complex organisational changes throughout the entire supply chain. This is resulting in changes in domestic markets as well, because "the purchasing decisions and supply network requirements of foreign retailers are leading to a rapid and dramatic consolidation in the distribution, wholesale and manufacturing/agricultural production sectors of host economies" (Wrigley *et al.*, 2005).

In the health sector, private firms are shaping the delivery of services and establishing a supply chain based on referrals from smaller medical practices. For example, in South Africa the three main private health-care providers (Netcare, Life Healthcare and Mediclinic) are not restricted to the domestic market. Netcare "exports" health-care services to the capacity-constrained National Health Service (NHS) in the United Kingdom (Mortensen, 2008).

The focus on manufacturing has at the same time deflected attention from other sectors that are important in developing countries, such as extractive industries and infrastructure. These sectors develop and use sophisticated innovations that could offer significant technological learning opportunities, in addition to supporting innovation in other sectors, particularly in the case of infrastructure (see Chapter 4). Furthermore, in developing countries innovation in organisational processes generally receives scant attention. This may be due to the general bias in innovation systems literature towards the manufacturing sector.

Innovation in low and medium technologies

The innovations systems approach argues that innovation in low and medium technologies is more attainable than innovation in high technology (Edquist, 2001; Lall and Kraemer-Mbula, 2005). Again, the focus is generally on the manufacturing sector, which represents a very small share of gross domestic product (GDP) in Sub-Saharan Africa. Between 1965 and 2005, manufacturing value added in Sub-Saharan Africa has not risen from 15% of GDP in the 1960s (UNCTAD, 2008). The classification of production activities based on the technology intensity of products does not fully reflect the current situation in developing countries. As pointed out above, agriculture is not necessarily a low-technology sector, as the cut flower industry in Kenya or fishing in Uganda demonstrate (Kiggundu, 2006). Both involve the integration of highly sophisticated innovations to ensure that perishable goods meet required standards on arrival in their final overseas markets, particularly specific sanitary and phytosanitary requirements in the case of food items, and increasingly that they meet ecological and environmental requirements. In the health sector, South Africa's private health-care provision in the United Kingdom is a high-technology-intensive service (Mortensen, 2008).

Recent thinking on innovation systems has begun to question the relevance of the classification of sectors by technology intensity and to recommend a focus on innovation in the so-called low- and medium-technology sectors in developing countries.[9] These

sectors consistently demonstrate their ability not only to draw on sophisticated technologies but also to shape innovation in high-technology sectors. Furthermore, innovations based on the use of high technology, particularly in infrastructure, which directly target low-income earners, have emerged in developing countries in banking services, IT services, medical services, etc.[10] Robertson *et al.* (2009, p. 441) point out that "it is a common error to regard dramatic technological advances such as information and communication technologies or biotechnologies as 'industries', tied to particular product ranges… [T]hey represent high-tech activities that become pervasive in the guise of general purpose technologies (GPTs), and their adoption therefore spreads across a wide swathe of user 'industries'."

Incremental innovation

Innovation is a process of experimentation which mainly involves a myriad of modifications and transformations of products and processes. Some are radical changes and others are small improvements. It has been argued (Dutrénit, 2004) that developing countries are more likely to engage successfully in incremental innovations than in radical innovations. Innovation at the technology frontier generally requires substantial investments in R&D, which may not be available in developing countries. Furthermore, the development of radical technologies entails greater risks owing to the degree of uncertainty and is often characterised by long gestation periods. R&D which focuses more on development than on research plays an important role; it provides opportunities to make improvements and adaptations (innovations) and offers opportunities for technological learning. Innovation and technological learning occur simultaneously and are important for the improvement of products and processes.

Other forms of incremental innovations have been described. For example, Srinivas and Sutz (2007), in their analysis of innovation as a means of resolving local challenges, note that there are challenges that are specific to developing countries. Innovation is required to obtain a non-existing product or process and may involve non-existing knowledge. This calls for a fairly different approach to innovation than what is required to improve products and processes for competitiveness. These authors also identify challenges in developing countries that have not been met, not because no solution exists but because it is not accessible to developing countries.[11] Developing an alternative that is accessible to developing countries generally depends on innovation efforts that can require substantial investments and modifications.

Absorptive capacity

Absorptive capacity has been defined as a firm's ability to recognise the value of new external knowledge, assimilate it and apply it to commercial ends (Cohen and Levinthal, 1990). The acquisition of absorptive capacity in developing countries has received much attention in the literature (Liu and White, 1997; Kim, 1997; Criscuolo and Narula, 2002; Narula, 2004; Narula and Marin, 2005); it is mainly associated with the accumulation of human capital and investments in R&D.

The ability to absorb existing knowledge has complex facets and the underlying dynamics are not well understood, particularly in policy interventions in Sub-Saharan Africa (Wamae, 2006, 2007). However, authors commonly agree that absorptive capacity is critical for access to and use of existing knowledge. It is argued that it is important for developing countries to build their absorptive capacities by focusing on exploiting existing

knowledge. The rationale behind this proposition is closely linked to that underlying incremental innovation.

Incremental innovations provide opportunities for extending and deepening technological learning. Technological learning contributes to the development of competences that are fundamental for developing the ability to use knowledge (absorptive capacity) that exists but is new to the context. This capacity can provide the basis for engaging not only in replication but also in innovations that are new to the world. For this to occur, it is crucial to have a clear understanding of the distinction between capabilities that are required for operating production systems and those that are capable of changing production systems (Bell, 2007; Wamae, 2007). The latter capabilities are critical for providing solutions to local challenges by converting knowledge to value. Increasingly, this includes finding new uses for emerging technologies such as information and communication technologies. An example is provided by the mobile telephone money transfer innovation (M-PESA), which offers low-income earners a secure and rapid solution (Hughes and Lonie, (2007).

The creation of the capabilities required to convert knowledge to value largely depends on deliberate efforts, involving substantial cost, to provide opportunities for technological learning. These opportunities provide a milieu for engaging in "innovative technology-developing tasks" (Wamae, 2009, p. 203). Most Sub-Saharan African countries attach little importance to this form of capabilities. Efforts aimed at knowledge generation tend to focus on public research institutes, and in particular on science and technology rather than on innovation or the general application and commercialisation of science and technology outputs. By and large, efforts to exploit the backlog of existing knowledge offer limited opportunities to acquire the capabilities required for converting knowledge to value.

The development of an absorptive capacity that focuses on operating or production capabilities and pays no attention to capabilities for transforming knowledge into new configurations is unlikely to contribute effectively to the innovation for development agenda in Sub-Saharan Africa. There is no evidence in any regions of the world to suggest that is possible to embark on a successful path of innovation for development without intervening directly in extending and deepening technological learning (Wamae, 2006). R&D that focuses on development rather than on research plays an important role in strengthening the ability to improve processes and products. It is also important for extending and deepening technological learning, which is necessary for resolving context-specific problems. Ely and Bell (2007, p. 24) provide a clear statement on this point.

> "But in most … developing countries this approach has been much more idiosyncratic and intermittent, and rarely the subject of explicit policy initiatives. The development of a dynamic and creative engagement with technology has more commonly been left to emerge slowly, sparsely and sporadically, and the two dimensions of innovation-centred interaction with imported technology have not been pursued aggressively with active support from policy – neither *(i)* using the process of importing technology as an important vehicle for strengthening innovation capabilities, nor *(ii)* ensuring that continuing innovation is the central feature of using what was earlier imported."

Changing innovation dynamics and implications for learning and innovation processes in developing countries

The emergence of a knowledge-based economy and globalisation are continuously restructuring the dynamics of innovation. New poles of innovation are beginning to emerge, particularly in Asia's newly industrialised economies and in the so-called BRICS (Brazil, Russia, India, China and South Africa), particularly China. The changing dynamics are also calling for new perspectives and approaches to innovation, including the conversion of knowledge to value that directly targets low-income earners, who have previously been considered as marginal to innovation processes. For Sub-Saharan Africa to benefit from the restructuring that is taking place, it is imperative that the issue of technological learning capabilities aimed at generating new knowledge as well as transforming knowledge to respond to development challenges is addressed.

Changing dynamics and innovative activities

The original Sussex Manifesto estimated that developing countries accounted for only 2% of the global gross expenditure on R&D in 1970 (Singer *et al*., 1970). This figure had risen to 21% by 2000 and Asia represented almost two-thirds of developing country gross domestic expenditure on R&D (GERD) (Ely and Bell 2007). This suggests that developing countries, particularly in Asia, are playing a growing role in the generation and conversion of new knowledge to value.

Table 3.1. World share of developing countries' GERD, 1973, 1990 and 1999/2000

Percentages

	1973	1990	1999/2000
Developing countries	*2.9*	*10.2*	*21.0*
Asia	-	5.0	13.0
Other developing countries	-	5.2	7.9

Source: Ely, A. and M. Bell (2009), "The Original —Sussex Manifesto: Its Past and Future Relevance", *STEPS Working Paper 27*, STEPS Centre, Brighton.

China is at the centre of the restructuring that is taking place in knowledge generation and innovation. As Professor Martin Reis observes in the Reith Lectures (2010):

> "Of course the biggest tectonic shift in the world's science stems from the burgeoning growth in the Far East – in China above all. Since 1999, China's R and D spend has risen by 20 percent each year – up to a level that's now second only to the US.
>
> "China's technocratic leadership has astutely targeted its scientific investment in 'growth areas'.
>
> "Look, for instance, towards the city of Shenzhen. There, a 500-strong research team is hard at work, on the front line of genetic research. They were only established eleven years ago. Now they have more sequencing capacity than anywhere in the world – enough to sequence 10,000 human genomes in a year. And China strives to lead, too, in the quite different field of solar power."

China's emergence at the forefront of knowledge generation has implications not only for technological leaders in Western economies, but also for the transformation of knowledge for the benefit of developing countries. Technology platforms for new and emerging technologies, including biotechnology, nanotechnology and communication technologies, are playing a major role in creating technological solutions in the South for challenges in the South. A new perspective on this South-South approach to innovation argues that the relevance of developing country markets for Chinese and Indian innovations is that it is the emergence of new markets in developing countries rather than the emergence of new technologies that is driving the restructuring of innovation dynamics. It is disruptive markets rather than disruptive technologies that are increasing shaping innovation dynamics (Kaplinsky *et al*., 2009).

> "Thus, we anticipate a new generation in innovation systems, with the core development of low-income economy-specific products and processes being located in low-income economies, particularly China and India. Because of the context of their development, they are particularly appropriate for other low-income economies. We can already observe this in Africa, for example. Many of the professional elites examining the entry of China into the continent are dismissive of the very poor quality of many Chinese products. However, from the perspective of very poor consumers, a wireless costing $2 may look and sound tinny, and may have a relatively limited lifespan. But it is cheap, and it is appropriate. Similarly, on health, some generically produced drugs (such as those treating TB and malaria) may not have the same level of therapeutic benefit as the newest variants of treatment, but they are low-cost and will often minimize the worse aspects of a morbidity inducing condition such as chronic high blood pressure." (Kaplinsky *et al*., 2009, p. 191)

Although Sub-Saharan African countries, excluding South Africa which represents a significant proportion of the region's knowledge creation and innovation, represent for the most part a market for innovations rather than a source, this imbalance will only be addressed if local firms engage in innovation. The importance of addressing this issue lies in the fact that the ability to influence the orientation of innovation trajectories, and therefore to provide solutions to development challenges, depends on the existence of significant innovation capabilities (Bell, 2009). There is some evidence that the potential to engage in knowledge conversion for the benefit of low-income earners exists in some of these countries. For example, Equity Bank, a locally owned bank in Kenya has successfully offered banking solutions to the poor who were locked out of conventional banks. The demand for banking services by the unbanked population drove Equity Bank to undertake innovative activities that included the exploitation of information and communication technologies to deliver affordable banking (Wamae, 2009). However, most firms in Sub-Saharan Africa are not able to generate adequate technological capabilities that would allow them to use new knowledge to address local challenges. As discussed above, deliberate efforts are required to develop capabilities that "play a direct and critical role in adapting and modifying specifications for integration into processes, products and services, particularly owing to their close association with the dynamics of demand" (Wamae, 2009, p. 201). This point is discussed further in the following section.

Learning as a key issue in innovation for development

Learning, as the basis for the acquisition of knowledge, both tacit and codified, is essential for developing and upgrading innovation capacity. The nature of the learning process determines the extent to which innovation in both products and processes can be

undertaken. In an innovation systems perspective, there are differences in the ability to learn at the macro and micro levels because learning is a highly complex social process.

Learning at the macro level

For Lundvall and Borrás (1998), the "learning economy" is a fundamental concept. The authors stress that, with regard to economic development, a learning economy primarily concerns the ability to learn and adapt to change. It is not the stock of existing knowledge but the ability to learn that drives progress. Differences in the rate of learning determine an economy's ability to expand and progress. Developed countries tend to have a greater ability to learn than developing countries, and this is the source of a "learning divide" (Arocena and Sutz, 2000). Because many developing countries have low rates of learning, they are locked into activities (such as the production of products with low value added) that offer limited opportunities to improve their learning capabilities.

At the macro level learning is determined by the presence of adequate opportunities. These depend on access to education, on the one hand, and, on the other, on a context that encourages the creative application of knowledge to resolve challenges. Innovation depends on the creation of basic technical abilities at the tertiary level that are predisposed for adoption and further development within productive activities. The acquisition of basic technical abilities in turn depends on the existence of basic cognitive abilities at the primary and secondary levels of education. Learning as a fundamental process for innovation therefore "involves a two-stage process consisting of two sets of necessarily complementary activities: the acquisition of basic technical skills and knowledge via tertiary education and training; and subsequent learning within productive employment that adds critically important complementary skills and understanding" (Wamae, 2009, p. 202)

Learning at the micro level

As discussed earlier, the firm is the main locus of innovation. Understanding what takes place within firms in relation to innovative activities and learning processes is the key to identifying the dynamic interplay that results in innovation. Technological learning capabilities are acquired within the firm and are critical for the process of development. However, this is not an automatic process; it requires deliberate investment efforts and leads to different results depending on the specific learning opportunities provided. The two main outcomes are: skills that offer opportunities to directly alter the configuration of existing knowledge to create wealth; and skills that support the previous skills by generalising the application of the modified configurations. How intensively technological learning capabilities are deepened and extended within the firm depends on specific processes that involve deliberate costs (Wamae, 2007, 2009). These technological learning capabilities facilitate the identification of specific needs and potential solutions because they are the "focal point in systems where the poorly specified demand for knowledge and other inputs to innovation in the production of goods and services is identified and crystallised in concrete and specific forms" (Bell, 2006, p. 19).

International relevance of learning

Lundvall and Borrás (1998) recognise that globalisation of technology offers new opportunities for developing countries, but note that these opportunities are not available without deliberate efforts to absorb knowledge through endogenous learning. For instance, the South African aerospace industry is currently undergoing a steep process of

technological learning and adaptation as a consequence of global changes in production, consolidation of large aerospace multinational corporations (MNCs) and fragmentation of production. South African aerospace companies are developing new niche markets, introducing process and product innovations, and restructuring in order to attract international investors and become the international suppliers of large multinationals (*i.e.* Boeing or Airbus), against other low-cost locations (*e.g.* Brazil and China). Large MNCs increasingly demand higher capabilities from suppliers in developing countries, and domestic companies need to respond by upgrading their production capabilities as international suppliers. At the same time, the integration of firms into international supply value chains generates new avenues of learning through training, knowledge sharing and joint production with foreign firms (Kraemer-Mbula, 2009). This example remains an exception in Sub-Saharan Africa, where innovation in most economies is based on traditional sectors such as agriculture and extractive industries even though, as already mentioned, the international dimension of learning is also present in these traditional sectors.

The relevance and impact of theories of innovation systems on policy in Sub-Saharan Africa

The innovation systems framework provides developing countries with useful theoretical insights. However, it is important to complement these with empirical analysis in order to adapt them to Sub-Saharan Africa and provide a suitable basis for designing specific innovation strategies. Edquist (2001) points out that the innovation systems "approach can be used as a framework for formulating specific innovation policies. However, this cannot be done on the basis of theories alone. Specific empirical analyses must explicitly compare different existing (national, regional or sectoral) innovation systems." This section discusses some theoretical aspects that are important for innovation policy in Sub-Saharan Africa.

Contextual issues and the innovation systems approach to policy design

Successful innovation requires policy intervention that nurtures learning in order to upgrade technological capabilities and infrastructure (Katz, 1987; Lall and Pietrobelli, 2002). Policy strengthens innovative activities by orienting technological learning and innovation processes. The literature on innovation systems recognises that more innovative countries not only have higher productivity and incomes, but are also better able to deal with social challenges. More specifically, policy determines whether innovation will enhance development outcomes through the design and implementation of innovation policies that are socially oriented, and by ensuring that other areas of policy which are implicitly related to innovation policy, such as procurement policy, do not undermine the ability to integrate social goals (Sutz, 2007).

Innovation can and does occur in the absence of policy, particularly in developing countries where forms of social and economic activities sometimes "bypass" the laws. As a result, some of the innovations that emerge may have negative impacts on development. For example, in developing countries, traditional medical practice often fails to be scrutinised by standards and quality assurance agencies, and innovations in traditional medicine counteract the health-enhancing effects that contribute to social development. Innovations that do not lead to development-enhancing effects exist, and emerging research on "illegal" innovations provides some examples (Rush *et al.*, 2009).

Evidence-based policy

Empirical evidence is required to determine which organisations and institutions require changes in order to adapt and strengthen the innovation system. Such evidence is critical for determining the balance between supporting existing innovation activities and undertaking informed efforts to identify and promote emerging innovative areas (Earl and Gault, 2006; OECD, 2007). It also provides a basis for benchmarking a country's performance over time and important lessons for policy learning. It therefore provides a basis for designing effective policies and implementing appropriate adjustments. It is also linked to issues of benchmarking and the adequacy of indicators that inform policy formulation and evaluation. Some commentators have recently recognised the importance of broadening the scope of innovation indicators beyond traditional input and output measures by incorporating systemic aspects related to the "process" of innovation, linkages and learning (Lundvall and Tomlinson, 2002; Kraemer-Mbula, 2010).

Policy coherence

Most Sub-Saharan African economies are preoccupied with major issues related to poverty, water, sanitation, health, social unrest and the like. These issues require co-ordination of domestic polices in various dimensions. In addition, there is increasing pressure to adhere to international regulations on global issues such as environmental degradation, global warming and international trade rules.

Insights from the innovation systems framework have to be adapted to the characteristics and complexities of innovation at the local level, on the one hand, and to international requirements, on the other. It is important to note that the challenges involved in meeting international requirements may inhibit the ability to direct efforts towards local innovative activities (Sutz, 2007). Nevertheless, local innovations targeted at resolving local challenges can have a major role in addressing international requirements.

Socio-historical aspects

The innovation systems framework is not intended to provide a "one size fits all" solution for Sub-Saharan Africa. These economies have major differences, with regard not only to their structures, but also to their socio-political characteristics. In providing evidence-based research for policy making, it is important to capture the role of history in shaping social interrelations and networks. For instance, in Kenya, South Africa and Uganda, differences in the structure of business ownership are clearly shaped by different socio-historical tensions. In South Africa, apartheid limited business ownership by the majority of the population, thereby curtailing entrepreneurial activity (Schneider *et al*., 2007). Kenya's post-independence period was marked by a strong desire to "kenyanize" the economy in order to break away from the isolation that had set in during the colonial period. Public servants were allowed to operate simultaneously as government employees and businessmen, and this resulted in a vibrant informal sector. In Uganda, the expulsion of Asians during the 1970s resulted in the lack of a middle entrepreneurial class. These socio-historic differences provide very different challenges for policies targeting innovative activities. In turn, outcomes of innovation policies that are shaped by different challenges are likely to produce different results.

This section shows why the theoretical link between innovation and development requires contextualisation through evidence-based research. This is important in order to orient innovative activities appropriately. Furthermore, coherent explicit and implicit innovation policies are necessary to create and maintain an environment which induces opportunities for innovation. Rapid technological change requires policies to be flexible and anticipatory in order to effectively strengthen learning and innovative activities aimed at achieving developmental goals.

Other policy-related issues

The innovation systems approach is attracting interest in other types of policy issues, particularly in developing regions. These include autonomy and possibilities for policy experimentation, the need to extract high-level lessons from policy making or policy learning, and the importance of intermediary institutions and the demand for policy design and implementation.

Policy experimentation

Many authors have stressed the need to create room for policy experimentation in developing countries (Rodrik, 2008; Chaminade *et al*., 2009; Srinivas and Sutz, 2007; Juma and Yee-Cheong, 2005). Their views highlight the need to open up new development trajectories with greater emphasis on generating knowledge and learning not only at the level of the entrepreneur, but also at the level of policy. However, effective policy experimentation requires the existence of adequate learning mechanisms. It also requires a certain degree of policy autonomy and flexibility. An example can be found in Kenya's cut-flower industry in relation to carbon emission debates on environmental impacts (Wijnands, 2005; Bolo, 2008).

Policy learning

Policy learning requires the gradual development of a common vision on how to cope with the challenges and contradictions of the globalising learning economy (Lundvall *et al.*, 2002). Lessons from successful innovation experiences as well as from failures need to feed effectively into policy learning. Policy learning helps to identify not only new strategic priorities but also the specific causes of system failure. It can also help to achieve policy coherence.

Importance of intermediary associations

Intermediary institutions, such as business associations, community organisations, non-governmental organisations (NGOs) and donors, play a role in stimulating innovation system interaction and in strengthening the innovation capacity of the innovation system in poor communities in developing countries (Klerk *et al*., 2009). Given the multi-dimensionality of innovation and the complexity of integrating various types of knowledge in developing countries, the role of knowledge brokers in collecting, packaging and transmitting relevant knowledge for effective policy formulation requires further attention.

Demand-led innovation

In Sub-Saharan Africa innovation strategies have been traditionally driven by supply-side policies, with little regard to the role of demand in shaping innovation strategies. However, users are increasingly recognised as having an important role in the innovation process (von Hippel, 2005, 2007). They can solve problems and adapt existing goods, services and technologies for transfer to producers as "user innovations". Demand from users can also influence the direction and nature of innovation. The implications for policy, including intellectual property regimes, are still being studied (von Hippel and Jin, 2009; Gault and von Hippel, 2009). Chapter 4 stresses that demand in developing countries is largely shaped by the dominant informal sector. Responses of innovation systems to this demand are explored in Chapter 7.

Conclusion

This chapter has provided an assessment of insights from the literature on innovation systems as they relate to innovative activities in developing countries. These insights are more useful for providing general orientations than for specific rules for adapting the innovation systems perspective to developing economies. The complexity of the innovation process makes it fairly difficult to define closely the types of innovative activities that take place in developing countries. It is, nevertheless, important to seek a more comprehensive understanding of learning and innovation processes in developing countries. The dynamic nature of innovation often presents an array of choices that require heuristic selections that occur through productive activities. Such selections may orient innovation into unpredictable paths that may support or inhibit innovations that are beneficial to society. Therefore, the selection of appropriate choices is critical for innovation for development.

Notes

1. A new Sussex Manifesto was launched on 15 June 2010.

2. The innovation systems concept was first mentioned by Freeman (1982). His ideas about the link between technology and development were inspired by the much earlier work of List (1841) on German's strategy for development. List argued for the need to build national infrastructure and institutions as a way of enhancing human competences and consequently spur economic development.

3. The elements of the national innovation system (NIS) have close similarities to structuralist views stressing that development is neither linear nor sequential, but a unique process shaped by a specific history, culture and socioeconomic context. A major contributor to this view stated that "underdevelopment is ... an autonomous historical process, and not a stage through which the economies which have reached a higher level of development have necessarily passed" (Furtado, 1961, p. 180). In other words, development should be understood not as a universal process but as an individual country's specific path of structural transformation. A perspective on the potential for convergence can be found in Motta e Albuquerque (2007).

4. "The dominant mode of thinking about innovation was to characterize this as a challenge involving the application of S&T (measured through R&D expenditure) to economic production." (Kaplinsky et al., 2009, p. 189)

5. Sen's work in the field of development economics has considerably influenced the Human Development Report, published by the United Nations Development Program (UNDP, 1990-2006), including the "human development perspective".

6. Schumpeter (1939), in his analysis of business cycles, was the first to highlight the importance of existing knowledge in creating value. He referred to innovations as new combinations, thereby underlining the fact that "existing elements" provide opportunities to produce "change" in innovation activities.

7. The term "firm" is used here to refer to units that convert knowledge to value across different sectors.

8. The firm had been identified as the key player in the innovation process even in the S&T approach. Bell and Pavitt (1993) point out "failure to recognise the firm as the central player in the accumulation of technology has been the major short-coming of technology policy".

9. Robertson et al. (2003) note that "it is not always possible to distinguish between high, medium, or low-technology industries in a way that is operationally meaningful. In practice, many industries employ a wide mix of product and process technologies."

10. See for example, the case of M-PESA in Hughes and Lonie (2007).

11. They mention a biological vaccine developed in the United States to demonstrate how its high costs have led to efforts to develop an alternative (a synthetic carbohydrate-based vaccine) that would be significantly cheaper.

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Chapter 4

Adapting the Innovation Systems Framework to Sub-Saharan Africa

by

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This chapter discusses the structural realities of Sub-Saharan African countries and how they relate to the conversion of knowledge to value. It focuses on two central aspects of innovation in developing countries: the dominance of foreign investment in natural resources (particularly in extractive industries) and in infrastructure; and the large informal sector, which contributes about 41% to gross domestic product in Sub-Saharan Africa and represents around 72% of total employment outside the agricultural sector. It does not aim to provide an exhaustive analysis of these issues but to encourage discussion in an innovation systems perspective.

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Introduction

Innovative activities in extractive industries and infrastructure[1] occur for the most part in the formal sector. Foreign direct investment (FDI), particularly by multinational enterprises (MNEs), is often touted as the most viable channel for bringing foreign knowledge to developing countries (*e.g.* Lall and Narula, 2004; Lipsey and Sjoholm, 2005). Despite the obvious importance of FDI in extractive industries and infrastructure in much of Sub-Saharan Africa, empirical evidence on the role of FDI in strengthening innovation processes tends to focus on the manufacturing sector, when in fact, over the last 25 years the manufacturing sector has made a relatively small contribution to gross domestic product (GDP) in the region (UNCTAD, 2008a). There appears to be an underlying assumption that extractive industries and infrastructure have little to offer in terms of technological learning. It is not clear why this is so. The first section of the chapter focuses on this question.

The innovation systems perspective emphasises that firms are the primary locus of innovation. Although the informal sector is mainly composed of firms, it has been largely ignored in an innovation systems framework. Yet, many Sub-Saharan African economies have large informal sectors on which the vast majority of the population depends. While firms in the informal sector are generally micro and small enterprises and are somewhat unstructured, this does not mean that they do not innovate. Successful innovation in this context can result in benefits not only to informal entrepreneurs, but also to the society as whole; the informal sector in fact produces economically viable and beneficial innovations that affect a large proportion of the population. The isolation of the informal sector from the innovation systems framework, which is generally concerned with the formal sector, does not necessarily indicate that innovation is of limited relevance in the informal sector. The second section of the chapter considers this question and argues that it may be that adequate tools for understanding innovation processes within the informal sector may be lacking.

The role of extractive industries and infrastructure in innovation and technological learning in Sub-Saharan Africa

Extractive industries and infrastructure involve very different activities. However, the two sectors tend to be connected (*i.e.* extractive projects usually generate infrastructure around them) and they share a number of commonalities. Both are critical sectors in Africa, and both are strongly affected by FDI. The literature on innovation systems has emphasised the relationship between FDI intensity and the acquisition of technological capabilities in host countries, typically in the manufacturing sector. Despite the relevance of extractive industries and infrastructure and their intensive reliance on FDI, they are generally neglected in the innovation systems literature as a potential locus of technological capabilities.

A brief overview of innovation systems thinking on FDI, innovation and technological learning

The importance of FDI in the innovation systems framework can be traced back to its early development, when the main concern was its impact on the innovative performance of the host economy.[2] A vast literature based on the innovation systems perspective discusses the role of FDI in innovation and technological learning in developing

countries, particularly in Asia and Latin America.[3] It focuses primarily on the importance of developing an interface for innovation-related interactions that promote knowledge flows from MNE subsidiaries of developed countries to local firms in developing countries, particularly in the manufacturing sector (Rasiah and Gachino, 2004; Gachino, 2006; Goedhuys, 2007). More recently, attention has turned to interactions which lead to two-way knowledge flows in host developing countries (Marin and Bell, 2006). There is also increasing research on outward FDI from developing countries (*e.g.* UNCTAD, 2006a; Rasiah, 2008). However, the geographical focus of the theoretical and empirical research on developing countries has been uneven.

Discussions in Sub-Saharan Africa continue to focus on attracting FDI by providing favourable macroeconomic conditions and adhering to international trade regimes. Almost no attention is paid to the importance of encouraging innovation-related interactions. The implicit assumption is that the mere presence of MNEs leads to substantial knowledge flows to local firms. However, even in cases of production-related links between MNEs and host country firms, it cannot be presumed that innovation-related interactions exist. Moreover, such interactions vary widely across sectors.

The literature on the relationship between FDI and innovation in host developing countries focuses largely on the manufacturing sector in Asian and Latin American economies. While this can be the source of useful lessons, these developing countries are very different from those of Sub-Saharan Africa. In particular, they have far more extensive manufacturing activities. For example, between 2000 and 2006, the share of manufacturing exports in total merchandise exports was 92% in East Asia, 56% in South Asia and 54.5% in Latin America, but only 26% in Africa (UNCTAD, 2008b). Moreover, many developing countries in Asia and Latin America have industrial structures that are relatively well established and significantly well endowed in human resources.

Over the last few decades, intense global competition among MNEs has been concentrated in the manufacturing sector, with commodities produced and marketed on an international basis. However, the participation of Sub-Saharan Africa appears to have been relatively marginal, despite the existence of bilateral agreements such as the African Growth Opportunity Act (AGOA) which was intended to buffer the adverse effects of the termination of the quota system in textiles and clothing on Sub-Saharan Africa. Clothing and textiles exports to the United States from Sub-Saharan Africa are reported to have fallen by 26% with the removal of quotas on China's clothing and textiles exports (Kaplinsky and Messner, 2008).

Lall and Pietrobelli (2005) attribute the dismal performance of manufacturing industry in Sub-Saharan Africa to structural constraints, particularly in skills and physical infrastructure. At the same time, they observe that most FDI inflows target resource-based industries and infrastructure. They suggest that these FDI inflows do not signify much in terms of technology "in that much of the FDI is either in the primary sector, particularly petroleum, or in infrastructure" (Lall and Pietrobelli, 2005, p. 323). The literature on FDI in Sub-Saharan Africa tends to affirm that extractive industries offer host countries limited opportunities for technological learning. However, the basis of such affirmations is not clear. In fact, some very sophisticated technologies are developed and used in natural resource extraction, and a number of economies have derived significant technological benefits from investments in extractive industries (Bell, 2007).

A brief overview of inward FDI in Sub-Saharan Africa[4]

FDI in Sub-Saharan Africa is concentrated in the primary sector and infrastructure. The evidence indicates that increases in FDI inflows to Sub-Saharan Africa are driven by extractive industries, a trend that is expected to continue. Indeed, FDI trends confirm that FDI inflows to Sub-Saharan African resource-based industries have increased rapidly over the last few years (UNCTAD, 2007). This growth is driven by an expansion of activities in the oil, gas and mining industries by transnational corporations. FDI in natural resources is often associated with increased investment in infrastructure (UNCTAD, 2008a).

Sub-Saharan Africa's share of the world inward FDI stock has been fairly small and has declined steadily over the past two and a half decades to 1.1% over 2000-04, down from 2.4% in 1980-84 (UNCTAD, 2005).[5] Nevertheless, the small absolute flows have been very important. In 2008 inward FDI stocks represented a relatively high proportion of total GDP in a fairly large number of Sub-Saharan African countries (33.2% compared to 24.8% in developing countries as a whole). As Table 4.1 shows, FDI flows in Africa increased significantly from 2005 to 2008 despite the global financial crisis (from 17.8% to 29% of gross fixed capital formation [GFCF]). The main FDI recipients continue to be producers of natural resources, although the table indicates that FDI inflows vary greatly from year to year.

Table 4.1. Inward FDI in a selected number of Sub-Saharan African economies

	FDI stocks as a percentage of GDP			FDI flows as a percentage of GFCF		
Year	**1990**	**2005**	**2008**	**1990-2000 (annual average)**	**2005**	**2008**
Africa	*11.7*	*28.6*	*33.2*	*7.3*	*17.8*	*29.0*
Chad	16.2	76.5	62.5	14.9	50.5	43.7
Dem. Rep. of Congo	20.6	56.5	74.0	19.1	57.7	65.1
Equatorial Guinea	19.0	130.3	80.5	38.1	125.7	20.5
Mauritania	5.8	98.5	63.5	6.3	392.8	15.9
Mozambique	32.6	69.2	39.4	13.4	7.1	26.5
Seychelles	57.8	115.7	180.4	19.1	105.3	127.3
Zimbabwe	3.2	62.9	70.4	6.2	176.4	19.2

Source: UNCTAD statistics, *www.unctad.org/*.

FDI stocks in Sub-Saharan Africa are relatively insignificant in comparison to those of Asia and Latin America. In spite of the fairly similar shares of world FDI stocks in the developing regions between 1980 and 1985, Asia has received considerably larger shares over time. In fact, while Asia's share of the world's FDI stock increased from an average of about 9.4% to 14% between 1980-85 and 2000-05, Latin America's increased marginally from 7.4% to 8%, while Africa's fell from about 6.4% to 2.5%. Of course, it can be argued that it is the nature or quality of FDI rather than the amount of FDI inflows that matters.

The main concern regarding FDI should be the extent to which inward FDI can be expected to strengthen knowledge flows through innovation-related interactions that lead to greater innovative dynamism in the host country and in turn induce greater FDI inflows. Although macroeconomic conditions and the general business environment influence FDI inflows, it is an economy's innovative dynamism that determines the extent to which such flows are beneficial to the host economy in terms of knowledge flows (see Chapter 5).

The continuing surge in world demand for natural resources is expected to remain the driving force for FDI inflows in Sub-Saharan Africa. In addition, over the last five years, FDI in Africa increasingly targets the exploitation of natural resources not only by Western countries with historical ties but also by new entrants from Asia, particularly China. It may be argued that Chinese investments in Africa operate in a manner fairly similar to that of the "Western" multinationals that have traditionally dominated FDI in the region. Nevertheless, Chinese multinationals have a number of different characteristics, as they are generally state-owned, have relatively little aversion to risk, and have undertaken large investments in politically sensitive regions (Buckley, 2008). Increasing investments by new entrants requires further attention.

The growth of FDI inflows in the extractive industries is also leading to a rise in FDI in infrastructure. For example, in the Democratic Republic of Congo there are significant projects in both the mining industries (diamonds, cobalt and copper) and in infrastructure development. South African investments in Africa are mainly in mining and infrastructure. Some of the largest South African investments in Africa are in mining (*e.g.* gold mining in Ghana, copper and cobalt in the Democratic Republic of Congo) (Naidu and Lutchman, 2004). Eskom of South Africa is involved in the first phase of an infrastructure project to rehabilitate the Inga hydroelectric power station in the Democratic Republic of the Congo as part of the "Unified African Grid" (UNCTAD, 2005). In the telecommunications sector, the South African giants, Vodacom and MTN, are rapidly expanding the telecommunications infrastructure in West and East Africa (Kraemer-Mbula and Muchie, 2010; UNCTAD, 2005). It would be very important to find ways in which such major infrastructure projects can serve as levers for innovation and technological learning in host Sub-Saharan African economies.

The much needed development of infrastructure, the lack of which appears to be a major obstacle for the manufacturing sector, largely accompanies the growing investments in extractive industries. It is important to assess and understand the role played by the activities of MNEs in the sectoral orientation of activities in host countries. In a dynamic context, this could reveal opportunities for strengthening and exploring new channels for developing the technological capabilities of local firms in sectors that attract substantial amounts of FDI. Progressive diversification into activities that attract relatively small amounts of FDI (such as manufacturing) might then be considered.

FDI-related innovation and technological learning in extractive industries and infrastructure

The concentration of FDI is highly skewed in favour of countries rich in natural resources. Together, Angola, Equatorial Guinea and Nigeria accounted for over 50% of inward FDI stocks in Africa between 2000 and 2004 (UNCTAD, 2008a). These countries have in common considerable investments in the oil industry. The surge in world oil demand is attracting FDI to these countries and to other oil-rich countries. Examples are investments in oil exploration activities in the Ogaden region of Ethiopia, investments by

Total (France) and Pecten in Cameroon, and investments in gold and aluminium in Ghana (UNCTAD, 2007).

Mozambique is reported to have become a leader among FDI recipients in southern and eastern Africa. By 2000, South Africa accounted for 28% of FDI mainly through partnerships in major extractive industry and infrastructure projects; the United Kingdom accounted for 22% through its participation in the aluminium project (Mozal), and Portugal accounted for 19% mainly in the services sector (UNCTAD, 2001). On the whole, large MNEs have a strong presence in the primary industries (UNIDO, 2005).

Development issues that relate FDI to innovation and learning in extractive industries remain insufficiently understood in Sub-Saharan African economies. The above observations help to highlight the importance of refocusing discussions on FDI and technological learning in order to reflect the important role of extractive industries and infrastructure. The increased demand for natural resources and the changing dynamics of MNEs, particularly in view of the new entrants from other developing countries, offer opportunities to do so. New forms of integration are emerging between Sub-Saharan African countries and other southern countries such India, China and even South Africa. It would be important to understand the specific forms of opportunities for technological capability development in natural resource industries (specifically extractive industries) and infrastructure. The existence of such opportunities is evidenced, for example, by Australia's construction industry and the development of petrochemicals in Brazil.

What can be said about innovation and learning in extractive industries and infrastructure in Sub-Saharan Africa? The dynamics of learning are likely to be different not only between these sectors and manufacturing (the main focus of the innovation literature), but also within them – differences can be expected within extractive industries (oil, gas, minerals, coal, etc.). Other natural resource sectors (agriculture, livestock and forestry) are likely to display sector-specific learning dynamics. The latter have received relatively more attention in the literature that examines innovation and technological learning (Clark, 2002; Smith, 2005; Hall, 2005; Kiggundu, 2006).

In the agriculture sector, while food processing may be considered a manufacturing activity, it is a downstream activity of the food sector and boundaries between the two may be fairly fuzzy. Food processing firms often produce agricultural raw materials and thus are active in a primary sector which undertakes technologically intensive activities. These technological activities relate both to the production of seed and other agricultural inputs and to downstream activities such as quality assurance/food safety management systems at the farm level, which provide inputs for agro-business activities. In addition, these activities tend to use a relatively high proportion of local content. The technological learning opportunities that may arise from natural resources and agricultural raw materials processing industries through the use of local content should not be underestimated. As an example, the policy department in Canada, Agriculture and Agrifood Canada (AAFC), deals both with food production through agriculture and food processing in the manufacturing sector (*www.agr.gc.ca/index_e.php*).

The origin of the FDI in extractive industries and infrastructure may also imply differences in the dynamics of learning. For example, projects that involve bilateral funding from industrialised countries are often undertaken by MNEs from these countries, whereas international donor-funded projects are increasingly undertaken by MNEs from developing countries, particularly China. The growing expansion of South African MNEs in Sub-Saharan African economies may also result in differences in learning dynamics in host countries. In fact a UNIDO survey (2005) found that South

African investors spent more on employee training in African countries than other foreign investors. For instance, PetroSA, South Africa's national oil company, established a capacity-building agreement for the development of technical staff in Sudan. It sent South African technicians to Sudan and Sudan sent personnel to South Africa "for training to enhance their technical know-how". The joint venture was described as commercially beneficial for Sudan and for "obtaining the critical skills they need to develop their oil industry further" (*Business Report*, 2005, quoted in Kraemer-Mbula and Muchie, 2010).

Understanding the specific characteristics of learning in extractive industries and infrastructure, particularly in view of the changes in global dynamics, remains a challenge. It is also important to understand, for example, how extractive industries are evolving in Sub-Saharan African economies owing to the increasing need to develop techniques to reach deeper oil wells or to explore new zones, and what this means for technological learning. The many issues surrounding the non-renewable nature of this source of energy, coupled with concerns about climate change and interest in renewable sources of energy, increasingly shape the dynamics of the industry. The implications of these changes for innovation and technological learning in relation to FDI in Sub-Saharan Africa are insufficiently researched despite their obvious significance. Moreover, debates on the role of FDI and the development of technological capabilities in Sub-Saharan Africa would perhaps be more relevant if greater attention were paid to natural resources and infrastructure than to manufacturing.

The role of donors in the conversion of knowledge in developing countries

The knowledge-based economy and globalisation are continuously restructuring the role of donors. The extent to which they have an impact on developing countries will increasingly be shaped by the commercialisation of knowledge to benefit marginalised populations in developing countries. Previously, donor emphasis in addressing the concerns of developing countries has focused on supporting the search for appropriate technology, particularly in health and agriculture. This has mainly taken the form of increased investment in establishing and strengthening public research institutes, which are generally viewed as the main purveyors and developers of knowledge. From one perspective it may be argued that this view is well founded, in that it relates to developing knowledge assets that are recognised as central to development. However, for donor involvement in the strengthening of knowledge assets to have a significant impact on developing countries, donors will have to engage in enhancing knowledge nodes and links that have previously received little attention, including in industry and infrastructure.

Undoubtedly a critical node at stake here is that of design, engineering and associated management capabilities (Bell, 2007; Wamae, 2009). These capabilities are in part responsible for the disarticulation that characterises innovation in developing countries. The role played by donors in the commercialisation of knowledge in developing countries is unlikely to substantially affect innovation dynamism unless it addresses these capabilities, to a large extent within the private sector. More generally, the peculiar nature of technological learning in non-R&D-specific activities requires concerted attention within the broader effort of strengthening the general innovation environment.

Of course, placing the private sector on the donor assistance agenda raises a fundamental question with regard to the general principle of limiting the benefits that may accrue to the donor while maximising those intended for the beneficiary. This may be construed as shifting attention from the public sector, which is thought to be better placed to ensure equitable distribution. The public sector has historically been the main beneficiary

of donor assistance and efforts have been made over time to change the nature of relationships between donors and the public sector. For example, there has been a radical shift from tied aid to more collaborative assistance. In practice, however, it may be argued that other forms of misalignment may have emerged or been reinforced and the principle may not render donor assistance significantly more successful in strengthening the delivery of knowledge assets for socioeconomic benefits in developing countries (Hall and Dijkman, 2008; Clark, 2008). Perhaps it is not too early to make better attempts at integrating market demands into the relationships between donors and developing countries. This may involve some rethinking of the general principle or, to put it more bluntly, of the reciprocal knowledge benefits of donor assistance. Besides, international collaboration on research and innovation between donor countries and developing countries already involves the private sector.

There is some documented evidence of donors' attempts to reconcile the provision of opportunities for knowledge exploitation and commercialisation by the private sector, on the one hand and, on the other, delivery of assistance to developing countries. In the development of the M-PESA service, Hughes and Lonie (2007, p. 65) noted that "[t]here has been much positive discussion in recent years about donor agencies seeking new ways to deliver funds to those who need it most, directly and in a more efficient manner, so that the capital is productively deployed. At the core of these initiatives is a willingness to find more effective ways of delivering assistance." This donor interest increasingly results in funding of the private sector, including from industrialised countries, as in the case of Vodafone. "In 2000, the UK government's DFID [Department for International Development] established the Financial Deepening Challenge Fund (FDCF). The FDCF fund managers and the proposal assessment team were looking for innovation. This could involve the development of a good or service that was not previously available in a target market, a new service that gave customers access to goods or services that would previously have not been available, or the application of a technology that reduced the costs of service provision. Many of the successful applicants were large, well-known private sector companies that faced challenges similar to Vodafone's in pursuing what would perceived as low yield projects. The entrance of a telecom company into a funding competition for the financial services sector took a few of the FDCF proposal review team by surprise, but we overcame some initial cynicism and were awarded funding of nearly £1 million, which was matched by Vodafone." (Hughes and Lonie, 2007, p. 67)

The DFID funding benefited the "unbanked" population which now has access to rapid and secure money transfer services via mobile telephone. It has also benefited Vodafone, not only through the benefits that accrue from the money transfer service to the unbanked. It now also holds a patent that has resulted from focusing on a disruptive market. The extent to which donors will have an impact on developing countries will increasingly be shaped by the commercialisation of knowledge aimed at benefiting marginalised populations in developing countries. Donors are likely to have a much more far-reaching effect on the populations of developing countries if they extend support not only to foreign firms operating in developing countries, but also to developing country firms engaging in innovation activities. Supporting such local firms will involve paying great attention to their design, engineering and management associated capabilities.

With regard to extractive industries, the Ugandan oil sector illustrates various opportunities for donor support in the development of local technological capabilities in this sector. It is noteworthy that although the technological capabilities required in the sector naturally involve R&D-specific skills, non-R&D-specific skills clearly play a critical role in dealing with the various complex issues in the sector. For example, drafting a

suitable policy and negotiating favourable terms with foreign companies can significantly determine the success of creating technological learning opportunities for local firms through innovation-related interactions with foreign firms. This would in the longer term influence the ability of local firms to produce and convert knowledge to value. As pointed out earlier and discussed in the previous chapter, technological learning within enterprises involves deliberate costs by the firm, and policy influences the extent to which entrepreneurs are willing to incur such costs. Donors may, for example, support the extension and deepening of technological learning in extractive industries.

Box 4.1. Ugandan Oil: no local technological capabilities, no oil?

"Petroleum in Uganda is reported to have been discovered in the 1920s, yet oil production is expected to begin next year – close to a century later. Various explanations could be put forward regarding the apparent excessively long duration between when oil was discovered and when its production is expected to commence, including the Second World War down to a civil war that ended in the 1980s. The period that captures attention here is that of the last two decades during which there has been a relatively favourable investment environment in the country."

"The principal prospective area for petroleum exploration in Uganda is the Albertine Graben, which extends into DR Congo; the Ugandan part covers some 23 000 sq. km. To date, only less than half the area has been explored and it is estimated to have about 600 million barrels of resource *i.e.* 100 000 barrels of oil per day for 20 years. The Albertine Graben has been divided into nine exploration blocks, five of which have been licensed to oil companies which include Heritage Oil and Gas Uganda Ltd (UK), Tullow Uganda Operations Ltd (UK), Neptune Uganda Ltd. and Dominion Uganda Ltd."

"Over the last 20 years, the government of Uganda has resolved not to authorise petroleum production until local expertise is developed. Systematic training in various disciplines of petroleum exploration, petroleum economics, petroleum law and petroleum engineering was undertaken during the period. A local team of professionals drafted the policy on oil exploration and has helped the government to sign favourable agreements with the explorations companies."

"The president of Uganda in a visit to Nigeria last year for a learning experience stated that Uganda needed to develop its local manpower in the sector and was particularly interested in training its personnel at Nigeria's Institute of Petroleum. Uganda also has plans to start its own petroleum institute. The government appears to be focused on prioritising the socio-economic benefits of Ugandans, including improved roads and railways, access to clean water, health care and education etc."

"One important observation is the concerted government effort to develop local technical skills for the sector. The President is reported to have said that the country would be ready when there were Ugandans well trained to be part of the exercise. The Ugandan energy minister is quoted to have recently reiterated the government's emphasis on the need to develop local expertise: 'Our objective is to process the oil. We don't want to export it… Our aim is to get an economic return, to get jobs, investment. We don't want anything raw to get out'."

Source: Assimwe, A. (2009), "Oil, Oil, Everywhere!", *New Africa,* March, pp. 42-43.

Watkins, E. (2009), "Uganda Wants All of Its Oil Refined Domestically", *Oil and Gas Journal*, Vol. 107, Issue 11 16 March.

East African Petroleum Conference (2009), "Uganda: History of Petroleum Exploration, Current Status and Future Programs", *www.eapc09.org/eac.php?c=ug*.

The quest for knowledge is likely to lead to stronger knowledge links between the private sector in donor and developing countries. This will continue to raise an array of opportunities and challenges.

A large informal sector and converting knowledge to value

This section describes the informal sector in Africa and discusses the implications for innovation and learning of an innovation systems framework, although the informal sector has so far received limited attention in this framework. A much more detailed analysis of trend dynamics and practices in the informal sector would be required to identify specific opportunities and challenges accurately.

Definition and overall features of the informal sector

In this chapter, the term "informal sector" is used to refer to micro and small enterprises (MSE) whose productive activities are neither illegal nor underground.[6] The chapter adopts the current International Labour Organization (ILO) definition of informal-sector enterprises as those "enterprises owned by individuals or households that are not constituted as separate legal entities independently of their owners, and for which no complete accounts are available that would permit a financial separation of the production activities of the enterprise from the other activities of its owner(s)".

This definition considers an enterprise "informal" when the size of employment is:

> "below a certain threshold to be determined according to national circumstances, and/or [enterprises] are not registered under specific forms of national legislation (such as factories' or commercial acts, tax or social security laws, professional groups' regulatory acts, or similar acts, laws or regulations established by national legislative bodies as distinct from local regulations for issuing trade licenses or business permits), and/or their employees (if any) are not registered" (Hussmanns, 2004, p. 3).

In addition, the term "sector" does not make reference to a branch of economic activity, but "groups together similar kinds of production units, which in terms of their principal functions, behaviour and objectives have certain characteristics in common" (Hussmanns, 2004, pp. 3-4).

The informal economy concept was initially developed in an African context (ILO, 1972).[7] The definition has broadened since in order to reflect the reality of most developing countries.[8] The current definition comprises activities that involve the provision of goods and services in exchange for remuneration, but which are not covered or insufficiently covered by formal arrangements (ILO, 2002a). The informal sector is thus typically characterised by: low entry requirements in terms of capital and professional qualifications; small scale of operations; skills often acquired outside formal education; and labour-intensive methods of production and adapted technology. However, all of these features are not always present. Many informal activities are not small-scale, there are formal skills in the informal sector, and certain informal enterprises are as technologically innovative as many formal-sector enterprises (Trulsson, 1997; Muller, 2005).

The informal economy exists virtually everywhere, including in advanced countries. It is, nevertheless, a dominant feature of low-income countries – where social safety nets and employment opportunities are scarce and wages are low – and it is expected to continue to grow (Ayyagari *et al.*, 2003). According to ILO figures (2002), informal employment accounts for 72% of non-agricultural employment in Sub-Saharan Africa, and for 78% when South Africa is excluded. These figures surpass those of all other developing regions.[9] Employment in the informal sector has been reported to be as high

as 93% in Benin (UNDP, 2007/2008) and 83% in Zambia (Government of Zambia, 2004, quoted in War on Want, 2006). Although average earnings in the informal sector are generally low, the total contribution to GDP is considerable. According to Schneider (2002), the informal sector contributes 42.3% to gross national product (GNP) in Sub-Saharan Africa, ranging from under 30% in South Africa to nearly 60% in Nigeria, Tanzania and Zimbabwe.[10]

Why is the informal sector of particular importance for Sub-Saharan Africa?

With close to 1 billion people, Africa is the second most populated continent after Asia and has the fastest population growth rate at about 2.5% a year. This high growth rate is accompanied by a decline/stagnation of jobs in the formal sector which is likely to drive more people into the informal economy.

The urban population in Sub-Saharan Africa is also growing faster than in any other developing region, at nearly 4% a year. In most large African cities, this translates into increasing segments of the population living in unplanned settlements on the periphery of cities, where the informal sector is the main source of income. This situation is likely to worsen.

The informal sector tends to persist in countries where income and assets are unequally distributed. Rising inequality across most Sub-Saharan African countries suggests that the informal economy is not likely to diminish in the foreseeable future.

There is a strong gender bias against women in the informal economy (Heintz, 2006; UNDP, 2007/2008) – particularly in LDCs[11] – as well as against vulnerable groups such as migrants and children. The sustainable development of African economies requires the protection and empowerment of these marginalised groups and their economic and innovative activities.

Activities in the informal economy are generally not registered or monitored and data are therefore scarce. Very few of these countries have regular systems of data collection in place and where they exist, differences in data sources, collection methods and measurement make comparisons difficult. The scarcity of data is a major concern for low-income countries; there is a strong link between employment in the informal economy and poverty – seasonal and casual workers are particularly susceptible to chronic poverty – and the link is stronger for women than for men (Chen, 2001; Kabeer, 2008).[12] Given the growth and significance of the informal sector in developing countries and particularly in Sub-Saharan Africa, there is an urgent need to study its role in the economy.

How does the informal sector emerge?

The informal sector originates from and is shaped by specific historical socio-economic conditions. Economic reforms, civil war, health pandemics and social exclusion are some of the most common causes, which can be grouped into three categories:

- *Informalisation of formal-sector employees*: A number of studies have looked into the effects of the adoption of structural adjustment programmes across Africa in the 1980s and 1990s. These policies encouraged the reduction of the public sector, privatisation of state-owned enterprises and liberalisation of trade. In many African economies, they led to a sharp decrease in public-sector employment and a search for opportunities in the informal economy. In Kenya for instance, the structural adjustment programme involved retrenchment and early retirement

schemes that offered packages to encourage self-employed entrepreneurial activities in micro and small businesses, generally categorised as informal-sector activities. Similarly, in Zambia, structural adjustment is estimated to have resulted in a decline in the share of formal-sector employment from 17% in 1991 to 10% in 1998. In Ghana the number of civil servants redeployed rose from 15 000 in 1989 to 150 000 in 1994 (War on Want, 2006).

- *Barriers to entry into the formal markets*: These may arise from the social exclusion of a segment of the population (indigenous groups, ethnic minorities/ majorities, religious groups, etc.) or of specific productive activities. In South Africa, for example, the apartheid government specifically banned certain segments of the population from participating in the formal economy. Since the majority of the black population found it difficult to obtain work in the formal sector, they sought alternatives in the informal sector. In contemporary South Africa, the incapacity of the formal economy to absorb informal operators has contributed to the persistence of the informal sector. Informal operators continue to be accounted for as endemic unemployment.

  Other barriers to formal markets take various forms, including excessive costs and regulations for setting up formal businesses as well as corruption around business start-up, granting of business permits and land titles. Such barriers encourage entrepreneurs to remain informal.

- *External forces*: Migration due to social unrest, and natural disasters and the impact of health pandemics such HIV/AIDS also tend to increase the number of participants in the informal economy. For instance, much of the informal sector in Mozambique can be attributed to the Sixteen Years War (1976-92) which drove migration from rural to urban areas. Refugees who relocated to urban areas mainly found their source of income in the informal economy (Xaba *et al.*, 2002). The more vibrant economic centres are also a magnet for immigration, including from neighbouring countries. South Africa has become a destination for refugees from other African countries suffering from civil unrest, as well as for those seeking income opportunities to overcome poverty in their home countries.

The origins may vary but the outcomes tend to be similar across the continent. According to Chen (2001), 93% of new jobs created in Africa during the 1990s were in the informal sector in the wake of economic reforms, globalisation and competitive labour market pressures. Xaba *et al.* (2002) provide some figures for various African countries. For instance, in Tanzania the growth rate of the formal labour force dropped from 3.3% in the 1980s to 2.6% in the 1990s. In Kenya, between 1991 and 1994, the informal sector grew by 16.1%, while employment in the formal sector grew by only 1.6%; by 1995 the informal sector employed 2.2 million and the formal economy 1.6 million. In Cameroon, 80% of all jobs created in 1992 were in the informal economy; in the early 1990s the formal sector in Malawi absorbed only 12% of the total labour force. Clearly, the bulk of new employment in recent years in Sub-Saharan Africa has taken place in the informal economy.

Heterogeneity of the informal sector

The informal economy is far from homogenous. Lack of clarity in discussions of the informal sector can lead to misunderstandings and undue generalisations about fundamentally different activities. Informal activities differ markedly with regard to the nature of and

scope for innovation. For example, the informal activities of street vendors, shoe shiners, junk collectors and domestic servants are different from those of informal transport services, small trading and commercial establishments, or providers of informal computer services. Heterogeneity may also be related to the structure of informal cultures of innovation (based on class, gender, ethnicity, religion etc.).

In view of the diversity of the informal economy, various categorisations have been made (for a summary, see Amin, 2002). This section only gives a few examples. Ranis and Stewart (1999) identified two broad sub-classifications: "traditional" and "modern" informal activities. The former are associated with low capitalisation, low productivity and income, small size and static technology. The latter were characterised by the authors as capital-intensive, dynamic in technology and skilled labour. Charmes (2002) differentiated informal economy activities according to the economic unit: own account operations (with an individual owner operator); family businesses (with an owner operator and, sometimes, unpaid family workers); and micro-enterprises (employer plus some employees). Based on findings from several observers, Haan (2002) classified informal enterprises according to their business orientation, *i.e.* from subsistence-oriented to more entrepreneurial, to income-generating activities, to micro-enterprises and small enterprises.

Such categorisations have fuzzy boundaries, and the categories in which entrepreneurs operate at a given time may overlap. Nevertheless, each of the categories is associated with a technological base and competences. This clearly has different implications in an innovation systems context (see Box 4.2).

Heterogeneity implies different needs, opportunities and constraints as well as differences in the ability to upgrade, adapt, learn and innovate. Haan (2002) summarised some of the differences based on studies in Ghana and Tanzania by Dawson (1993) which indicated the advantages of micro and small enterprises that are relatively more technologically sophisticated and show the ability to:

> "*(i)* upgrade their products and services to a level where they have been able to develop linkages with the new growth sectors of the economy; *(ii)* diversify out of product and service markets where economies of scale attendant on mass production favoured larger-scale competitors; *(iii)* occupy niches better suited to their economies of flexibility and serving an import-substituting function; and *(iv)* prepare themselves against market saturation by raising barriers of entry (in terms of cost of capital equipment and required skills). Conversely, enterprises that experienced little technological enhancement tended to remain largely dependent on low-income groups as their principal source of demand at a time when the purchasing power of these groups has declined, and they are susceptible to overcrowding of the market in which they operate." (Haan, 2002, p. 12)

In sum, informal enterprises differ substantially, in terms not only of their ability to generate income efficiently, but also of their average competences, management practices, capital investment and accumulation of technological capabilities. Moreover, the actors are a heterogeneous group with various reasons for joining the informal economy. These differences need to be acknowledged in order to address efficiently the challenges of innovation in the informal economy.

Box 4.2. Types of informal enterprises

Income-generating activities: This is the predominant type of MSEs, especially in rural areas. They involve a pre-entrepreneurial, subsistence type of self-employment, and function as "the employer of the last resort". Usually they concern part-time, seasonal activities based on traditional technologies, local materials and local markets. Examples include seasonal trading and hawking and many traditional craft activities.

Micro-enterprises: These are slightly bigger than income-generating activities. They involve a few family workers, apprentices and sometimes one or a few (up to ten) permanent workers. They are based on a mix of traditional and more modern but obsolete technologies. They face constraints for access to capital, have modest technical competences and lack managerial skills. They are generally linked to markets through importation of some of their production inputs, and their output targets local or nearby markets. Some have some potential for growth or at least for the development of entrepreneurial skills. Examples include small shops, metal working, carpentry, tailoring and various forms of repair services (*e.g.* radio and TV, cars, household appliances).

Small enterprises: These are firms with roughly 10 to 20 (sometimes 50) workers. They use non-traditional or "modern" technologies in at least some of the production or transformation process. Their products and services range from simple to complex and span a range of consumer types. The marketing pattern may be somewhat complex, involving innovation in raw material procurement and in marketing. These firms are often (on the margin of) the formal sector; they are usually registered with the local government and tend to pay some tax. They are generally based in urban areas. Examples include garment assembly, motorised transport, construction and medium-scale industrial agro-processing.

Source: Adapted from Haan, H.C. (2002), *Training for Work in the Informal Sector: New Evidence from Eastern and Southern Africa*, ILO, Geneva.

The informal sector in the framework of innovation systems

Academic research has focused on innovation as a driving force for development in the formal sector. This is perhaps based on the perception of a strong negative relationship between the size of the informal sector, on the one hand, and the level of economic development and quality of institutions, on the other. Institutional failure is largely viewed as responsible for the persistence of a large informal sector, particularly in Sub-Saharan Africa (Friedman *et al*., 2000).

Innovation is still understood as an activity which occurs within clearly defined sets of rules and norms (institutions) and is undertaken by identifiable actors (organisations) whose interactions (formal or informal) can be monitored, at least insofar as they enhance or impede the learning process that is crucial for stimulating innovation. This excludes the informal sector. Coverage is limited to small, medium or large enterprise operating in a relatively well integrated manner within the formal economy that are able to benefit directly from interactions with other formal organisations and institutions within and outside the economy.

Undertaking research on the informal sector in Sub-Saharan Africa is essential for at least three reasons: *i)* although a large informal sector is an important characteristic of less developed and developing economies, interest in understanding the potential of innovation within the sector remains patchy; *ii)* the informal sector has linkages with the formal economy, particularly through the exchange of goods and services; and *iii)* there are significant structural differences between the formal and informal sectors which affect the nature of their innovative activities. These differences are underpinned by differences

in their various activities. Within the informal sector, these differences are under-researched, and it cannot be assumed that they mirror differences in the formal sector.[13]

The following are some considerations which are relevant to the relation between the informal sector and the innovation systems framework.

Demand-driven innovation

The informal sector responds to the demand for goods and services in both the formal and informal sectors. It has dynamic enterprises that engage in intensive innovation processes in order to satisfy customer demand and expand their markets. Moreover, the opportunistic nature of many informal activities means that they involve "quick responses to market demand and supply" (Bryceson, 2002). In some informal enterprises, the capacity to adapt to new opportunities and new markets may surpass that of the formal economy.

Owing to the fact that the informal sector provides relatively affordable solutions, it is generally assumed that demand in the sector is based solely on the consumer's income level (Ranis and Stewart, 1999). Even so, that demand plays an important role in shaping learning and innovation processes in informal enterprises. For instance a study by Muller in 1978 (quoted in Muller, 2005) indicated that the quality of tools produced by blacksmiths in Tanzania's informal sector surpassed that of large-scale factories. This was attributed to the fact that informal sector blacksmiths (who were often farmers as well) better understood demand preferences in the informal economy and were able to use local knowledge to produce high-quality customer-tailored tools. Additionally, the author argued that customers preferred their products because they were able to adapt them swiftly to sudden changes in farming conditions.

The high rate of entry and exit of informal enterprises[14] reflects rapid changes in demand for products and services in the informal sector. Using data collected in the mid-1990s by Liedholm and Mead (1998), Haan (2002) found that in a sample of African countries, informal enterprises were established at a much faster rate than start-ups in industrialised countries (at an annual rate of 20% in Kenya and 30% in Botswana, compared to a typical 10% rate for formal start-ups in industrialised countries). However, little is known about the forces driving the birth and death of informal enterprises.

Skills in the informal sector

The processes of learning and innovation have several dimensions in the innovation systems literature. Learning is viewed as taking place at the individual level, at the level of the organisation, and at the collective regional and system levels. Learning processes play a fundamental role since they constitute the basis for innovation and accumulation of technological capabilities. Learning involves the generation, absorption and adaptation of both codified and tacit knowledge. Codified knowledge can be acquired through formal education and training, while tacit knowledge is based on experience, and is mostly transferred through employment and labour mobility. Tacit knowledge has been recognised as the basis for a sector's sustained competitive advantage. The high mobility of informal entrepreneurs not only within the informal sector but also to the formal economy, suggests that tacit knowledge is of central importance in the informal sector.

The exclusion of the informal sector from the innovation systems framework implies that the ability to convert knowledge to value through learning and innovation processes is not present in the informal sector. This section argues that the informal sector can

represent both an important source of formal competences and skills for innovation and a large pool of tacit knowledge involving connections between the informal and the formal sectors.

Operators in the informal sector are generally viewed as uneducated. This leads to an assumption that the sector is on the whole technologically backward and incapable of developing technological skills. However, the evidence suggests that there are increasing efforts to improve skills for the informal sector, for example through vocational training programmes (see Box 4.3). Additionally, and as pointed out elsewhere, the informal sector comprises a segment of actors with technical skills obtained through experience in the formal sector and/or in institutions of higher learning. On-the-job training, self-training and traditional apprenticeships are recognised as by far the most important source of skills training in Africa for the informal sector (Liimatainen, 2002; Monk *et al*., 2008). Traditional apprenticeships are individual, self-financing and self-regulating contracts that provide practical training and better prospects for employment after the training. However, skills applied in informal activities are also likely to be acquired in a formal setting (*i.e*. public or private education and training institutions). For instance, informal actors may be transient – operating temporarily in the informal sector – owing to bottlenecks in the formal sector or periods of transition (*e.g*. university graduates who are not immediately absorbed into the formal sector or civil servants made redundant).

Box 4.3. Skills development in the *juakali* sector in Kenya

Juakali is the Swahili term for Kenya's informal economy, and it literally means "hot sun". The informal apprenticeship system, as practised by *juakali* operators in Kenya, has proven to be effective in transferring skills in the informal economy. Although it was originally restricted to artisans, the term has come to include manufacturing, building and construction, distributive trades, transport and communication, and service industries. Currently, most output from the *juakali* sector satisfies demand for food and other basic needs by low- and middle-income rural and urban Kenyans. In 1998, the *juakali* sector was estimated to employ almost 3 million people or 63.5% of the labour force and has expanded since. According to the national economic survey, employment within the sector increased from 4.2 million persons in 2000 to 5.1 million in 2002. In 2008, 79.8% of all jobs in Kenya were in the informal sector with 92.7% of all new jobs created being in the informal sector. The *juakali* sector has received increasing attention from government programmes and international donors.

The sector is labour-intensive and operates in unregulated and competitive markets, where acquiring skills has become a major concern. Informal apprenticeships are the main source of skills provision in the *juakali*, although the government has actively engaged in the supply of skills in the sector. One of the best-known programmes is the voucher programme established as a pilot in 1997 under the auspices of the Micro and Small Enterprise Technology Project. This programme distributed training vouchers to informal operators which they cashed with a personally selected training provider of their choice based on their needs and objectives. Participants only paid 10% of the cost of the voucher while the rest was subsidised by the government. New training programmes were developed tailored to the needs of voucher recipients and offered in off-hours to fit work schedules. There is evidence of the positive impact that training had on those who participated in the voucher programme.

Source: Based on Johanson, R. and A.V. Adams (2004), *Skills Development in Sub-Saharan Africa*, Regional and Sectoral Studies, The World Bank, Washington, DC; Gadzala, A. (2009), "Survival of the fittest? Kenya's jua kali and Chinese businesses", *Journal of Eastern African Studies*, Vol. 3, No. 2, pp. 202-220; Government of Kenya (2009), *Economic Survey 2009*, Government Press, Nairobi.

African governments have started to realise the importance of facilitating skills development in the informal sector.[15] However, many challenges remain as knowledge about the activities and needs of the informal sector is weak. An effective strategy to support skills development in the informal sector would require filling many of the knowledge gaps that remain around the operations of this sector. Looking at the road ahead for the informal sector, King (1996, p. 189) claims: "The challenge, now that so many government policies are finally on paper in favour of small scale and micro-enterprise, is massively to support this quiet revolution that has already begun to happen, and encourage this technological confidence to move up market, to go to scale, even to contemplate what may now seem a pipedream – the implication of new information technologies for the juakali sector in Kenya."

In order to effectively address skills in a context in which the informal sector represents a significant proportion of the labour market, the formal educational and training system needs to be aware of the traditional values, as well as understand the competences that informal operators have, need and utilise (Singh, 2000). As Chapter 7 highlights, policy interventions cannot be decoupled from the socioeconomic and cultural contexts in which they are applied.

Participation in value chains

Effective integration into value chains is considered an important determinant of a firm's innovation and competitiveness. The more complex and innovative the value chain, the more likely it is that firms will undertake innovative activities that target demand (Kaplinsky and Morris, 2001). Informal activities are viewed as taking place outside the value chains in the formal sector. For instance, a traditional medicine practitioner is likely to operate in isolation from the national health-care system and/or global pharmaceutical value chains. Nevertheless, it has been suggested that some informal-sector operators participate not only in formal-sector value chains but also represent a significant share of the workforce in key export industries (Buckley, 1998; Chen *et al.*, 1999; Chen, 2001). This is the case for many home workers involved in the labour-intensive textile, garments and footwear industries, as well as in the production and servicing of simple machines and portable technology[16].

In cases where the informal sector operates in isolation from formal value chains, this can create constraints, for example for access to finance, which is critical for innovation.[17] However, this situation can also trigger innovative solutions, although such innovations are for the most part likely to remain localised and low-scale. Isolated informal sector activities can constitute enclaves in the sector in which they operate and in the economy; the ability to scale up innovations emanating from these may be limited. However, the disconnection of informal-sector activities from formal value chains does not imply that informal entrepreneurs necessarily operate in isolation. Little is known about the informal value chains formed within the informal economy. This is a topic requiring further research.

It is also important to examine the scope and nature of backward and forward linkages between informal-sector actors and formal value chains. Backward linkages show the extent to which informal-sector enterprises obtain inputs from the formal economy in the form of raw materials, technologies, intermediate products or final goods. Forward linkages show the ability of informal enterprises to supply the formal sector with intermediary or final goods, for instance through subcontracting. It has, however, been argued, on the one hand, that subcontracting can be responsible for "abusive" working

conditions in the informal sector (no minimum wage or social security), but also, on the other hand, that it can offer market opportunities to informal micro-enterprises by integrating them into formal-sector value chains (ILO, 2002b).

Another aspect that calls for attention in relation to participation in value chains is the degree to which informal operators have control over the returns to their work, *i.e.* how the value chain is governed or the extent to which different types of value chains provide bargaining power to various actors in the chain. Informal-sector operators are generally thought to have relatively little opportunity for control. A study on South African garbage collectors of recyclable waste (such as paper, glass and metal) found that their dependence on demand for waste products by the formal economy limited their bargaining power (May and Stavrou, 1989).

It is important as well to understand the linkages between the informal sector and value chains in the formal sector and to understand those in informal value chains. This is necessary to ensure that innovation is channelled in ways that improve the livelihood of informal-sector operators and also protect their human rights and ensure decent wages.

The role of intermediary organisations

The role of intermediary organisations in stimulating interactions across the innovation system and fostering innovation capacity is well recognised in the innovation systems literature (*e.g.* Klerkx *et al.*, 2009; Hall, 2005). In the informal sector, because it is considered for the most part as outside of a system largely focused on the formal sector, the scope for upgrading, modifying and improving competences through innovation would appear to rely mostly on individual initiatives by informal-sector entrepreneurs with limited support from the wider institutional framework. However, in recent years, various initiatives have sought to organise workers in the informal economy. In some instances the emergence of business associations that represent and safeguard the interests of the informal sector are making important improvements in the promotion of collective action in terms of market access, information flows, formulation of government policies, etc.

In Sub-Saharan Africa most such organisations operate in a local environment, *i.e.* in a market or street vending area or in a city. However, many organisations have recently expanded their efforts and membership to a national level, often with the assistance of trade unions; examples include the StreetNet Ghana Alliance (SGA), Alliance for Zambia Informal Economy Associations (AZIEA), Zambia National Marketeers' Association (ZANAMA), ASSOTSI in Mozambique and the Malawi Union for the Informal Sector (MUFIS). However, relationships between intermediary organisations of the informal sector and central governments have been reported to be weak (War on Want, 2006).

In some countries, intermediary organisations have demonstrated the ability of the informal sector to provide services that the state has failed to deliver. They play an important role in several ways. First, they facilitate training in product development and business skills and access to knowledge about good practices. Second, they sometimes assist in the development of innovative financial schemes that encourage investments which are often beneficial to the community as a whole. Third, they provide a platform for informal actors to co-ordinate their activities, exchange information and increase their productivity. Finally, they represent the informal sector in its dealings with local governments and constitute the base of political mobilisation in the informal sector. Such associations involve organisational learning and are a critical aspect of innovation.

The role of societal forces and power relations

The innovation systems approach recognises the importance of societal forces in influencing the nature and extent of interactive learning opportunities and innovation. Such opportunities can be stimulated and oriented into specific directions or altogether blocked for political reasons relating to power distribution. Kenyon (2007, p. 11) notes that "In Kenya, for example, the Moi government first encouraged the formation of 'juakali' or informal-sector groups but then backtracked out of fear that they might emerge as a political force that would threaten its position". However, even in the absence of such tensions, other challenges abound. The Kenyan government has over the past two and a half decades designed numerous policies for promoting *juakali* enterprises, but entrepreneurs remain largely unaware of them. Information flows between the formal and informal economy face specific challenges which may relate to cultural perceptions of the informal sector. The informal sector in Kenya is largely viewed as a provider of employment that contributes little to tax revenue. Efforts to support information flows between the formal and informal sector are therefore limited. Other challenges may relate to inappropriate policy requirements for the informal sector owing to poor understanding of its potential to contribute to the economy.

Conclusion

The innovation systems framework offers a platform for analysing innovation processes in Sub-Saharan Africa. It acknowledges the importance of creativity and interaction on innovative activities among many actors. Nevertheless, work is required to adapt the innovation systems framework to the reality of Sub-Saharan African economies, in particular the informal sector. This chapter has identified three major activities that constitute the base of Africa's productive system – extractive industries, infrastructure and the informal sector. Analysis of the systemic nature of these activities through a suitably adapted innovation systems framework would make a useful contribution to understanding learning and innovation processes in Sub-Saharan Africa.

In formal productive activities, there has been a tendency to focus on technological learning and innovation in the manufacturing sector. This sector is generally assumed to offer the most viable channels for making technical knowledge from foreign sources available to the local environment. The concept of development as industrialisation has diverted interest from the extractive industries and infrastructure as important sources of innovation and technological advance. The informal sector has been traditionally excluded from analyses owing to a lack of information. A first step towards creating the ability to convert knowledge to value in Sub-Saharan Africa is to study innovation and learning process in sectors that account for a significant part of these economies. Micro-level evidence can play a critical role in shedding light on these sectors and thus provide a basis for adequate policy for innovation and development. The OECD workshop, Innovating Out of Poverty, emphasised that agriculture needs to be recognised as a knowledge-intensive sector (OECD, 2009).

While there is some evidence of increased commitment to the sectors discussed in this chapter, it remains limited. Innovation processes are complex and may appear to be particularly so in the sectors discussed in this chapter. Nevertheless, a comprehensive rather than a partial analysis of these processes is necessary for further innovation and development in Sub-Saharan Africa economies.

Notes

1. Infrastructure is here defined as consisting of industries such as electricity, gas, telecommunications, water and sewage and transport infrastructure (airports, roads, railways and seaports) (World Bank, 2008).

2. The concept of national innovation systems later led to variants including regional and sectoral innovation systems (see Chapter 3).

3. There is an extensive literature on FDI in developing countries, largely based on standard economic models. This section primarily focuses on literature which takes an innovation systems perspective and looks at Sub-Saharan Africa.

4. The emphasis on inward FDI is not intended to negate the importance of growing outward FDI, particularly from South Africa, in which largely goes to other Sub-Saharan African economies.

5. These shares exclude South Africa which had 2.25% and 0.58% for the corresponding periods.

6. Illegal production can be considered to represent a contravention of the criminal code and underground production can be considered to represent a contravention of the civil code.

7. The term first appeared in a study of Ghana in 1971, but it was only in a report on Kenya (ILO, 1972) that the term was examined. The report identifies the informal sector as such and devotes a chapter to it.

8. Informal economic activities are constantly changing, and the definition of the informal sector has also evolved over time. The definition adopted by ILO in 1993 was broadened following recommendations from the Delhi Group on Informal Sector Statistics, leading to the current ILO definition. However, it is a relatively new concept in official statistics and is still not part of regular data collection in most countries.

9. Estimated at 51% in Latin America and the Caribbean, 65% in Asia and 48% in North Africa (ILO, 2002).

10. Recent data on the informal economy, in terms of both the contribution to the labour force and to national income, are generally updated estimates based on data originally collected in the 1980s and early 1990s.

11. On average female participation in the informal economy is 15% higher than that of men in countries with a low human development index (UNDP, 2007/2008).

12. There are some statistics on this issue in UN Statistical Division (2000). Chen (2001) notes that virtually all of the female non-agricultural labour force is in the informal sector.

13. The heterogeneity of the formal sector is well recognised and has been studied extensively within the framework of sectoral innovation systems.

14. The rate is presumably higher than in the formal economy, given the *ad hoc* nature of many of their activities.

15. For instance in Ghana scholarships are provided for the training of artisans. Moreover, the government articulated its commitment to "facilitate innovation and entrepreneurship within both the formal and informal economy to enhance factor productivity" in its National Medium-Term Private Sector Development Strategy 2004-2008. These efforts have been mainly geared towards formalising businesses, providing access to credit to MSEs and facilitating basic educational courses for the informal sector to make individuals and enterprises aware of the potential benefits of basic disciplines such as bookkeeping, banking and other entrepreneurship skills (War on Want, 2006).

16. In certain countries this type of informal work predominates. For instance in Kenya, *juakali* workers in the textile sector comprises the largest percentage of informal sector workers (Gadzala, 2009).

17. Buckley (1997) adds that the real problems facing micro-entrepreneurs "cannot be tackled solely by capital injections but require fundamental structural changes of the socioeconomic conditions that define the informal sector activity" (p. 1081). Rogerson (2001) emphasises the importance of market demand (low purchasing power), market access, lack of diversification, inadequate infrastructure, and poor access to raw materials as critical points for MSE intervention, stressing the importance of moving non-financial support services to the African policy agenda.

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Chapter 5

Knowledge Policy for Development

by

Dominique Foray*

This chapter presents a conceptual framework for innovation policy in developing countries, starting from a distinction between innovation systems in which actors are linked and a knowledge ecology in which the connections between actors are weak or absent. The approach distinguishes between the requirements of middle-income and least developed countries and considers the best ways to search for relevant areas of progress in science and technology, the means to advance the knowledge ecology, and the emergence of multiple innovation systems.

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Introduction

This chapter provides a conceptual framework for an empirically and analytically informed innovation policy for developing countries. The framework is based on the distinction between the knowledge ecology[1] and innovation systems. It emphasises the role of a particular model of innovation for growth in developing economies as well as the process of discovering what a country does best in terms of its science and technology specialisation.

The framework takes account of the heterogeneity of developing economies. On the one hand, there are the large and developing middle-income countries which are clearly catching up because of increasing exposure to foreign technologies through foreign direct investment (FDI) and trade and improved absorptive capacity. On the other, there are the low-income economies which have seen very little progress in science, technology and innovation over the last decade.

The chapter first takes stock of the most recent data on technological change and technology diffusion in developing countries in order to illustrate the difference between two classes of countries. Next, it argues that innovation in less developed economies has certain peculiarities. These countries must focus on research and development (R&D) and more informal learning activities to produce locally oriented innovations and to develop absorptive capacity. But, at the same time, locally generated spillovers from this R&D may diffuse away within the domestic economy. There are vast areas of economic activity which require innovation to serve local needs, where "local" may mean a large fraction of the world population. It is not true that innovating for global markets is the only game in town.

The chapter then turns to the framework for distinguishing between the knowledge ecology and innovation systems. It describes the process of discovery of the relevant domains for advancing science and technology in a given country, and derives the three main dimensions of responsibility for innovation and knowledge policy in developing countries. The final sections propose knowledge policy responses in these three dimensions:

- a search for the relevant areas for progress in science and technology;
- improvement of the knowledge ecology;
- the development of a suitable institutional framework (incentives) to facilitate the emergence and development of multiple innovation systems.

Different countries, different challenges for knowledge policy

This section examines the most recent data on technology diffusion and technology transfer (TT) to developing countries to see whether countries are using the various TT mechanisms (notably FDI, trade and licensing) effectively. It considers the extent to which these mechanisms act as engines for growth, and whether there is any need to reconsider the premise of the central role of FDI and trade as TT mechanisms in current policy. It draws on data from a recent World Bank report (2008) focused on technology diffusion.

The World Bank's current assessment

The World Bank puts at the centre of its framework of analysis two fundamental determinants of technology diffusion in less developed countries. The first involves the three main channels by which developing countries are exposed to external technologies: trade; FDI (and licensing, which can substitute for FDI); and a highly skilled diaspora. The second is the country's absorptive capacity, or technological adaptive capacity. This can be increased by policy interventions which lead to improvements in governance and the business climate, in human capital (increase in basic technology literacy), in the technological capacities of firms, and in access to credit on capital markets.

These two determinants are clearly related. They create mutual externalities and thus form a dynamic system with feedbacks. Such systems are well known and well studied in the literature on economic development. They generate multiple equilibria that are reached through virtuous (or vicious) circles (*e.g.* Stiglitz, 1991).

For example, as a country becomes more exposed to foreign technologies (through an increase in FDI) it may increase, up to a point, the returns to improvements in absorptive capacity. As absorptive capacity improves, the probability of spillovers spreading through the domestic economy increases. This in turn raises the economy's overall efficiency, and this positively influences decisions to locate more FDI in the country. As in any positive feedback system, there are virtuous circles which take the form just described, but vicious circles may also occur.

Virtuous circles

The basic message of the World Bank report is that many developing countries – notably the middle-income countries – have engaged in a virtuous circle, in which the basic components of the feedback system described above mutually improve each other. The increasing exposure to foreign technology (through FDI and trade) is co-evolving with increased dissemination and spillovers of these technologies within the domestic economy. As a result, by many measures, these countries have made outstanding progress in innovation and in technology adoption and deployment. The main indicators of such trends are:

- R&D and other innovation-related activities becoming significant drivers of productivity;
- a rising share of high-technology and capital goods imports;
- the expansion of exports of technological goods;
- an increase in FDI as a percentage of gross domestic product (GDP) and as a percentage of fixed capital formation;
- increased exposure to external technologies.

For these countries, trade and FDI therefore seem to be the main channels for accessing foreign technologies. TTs as a joint products[2] work quite well when absorptive capacity is sufficient to allow spillovers from the transferred technology to the rest of the economy. Good policies and governance remain of course essential in order to maintain FDI and trade at a high level and to continuously improve absorptive capacity.

The situation described above is consistent with the evidence on the positive relation between the reform of intellectual property rights (IPR) and the stimulation of TTs in middle-income countries. Indeed, Park and Lippoldt (2008) find that stronger patent systems tend to be positively associated with inward FDI and trade and that a strong patent system is positively and significantly associated with TT (*i.e.* inflows of high-technology products, such as pharmaceutical goods, chemicals, aerospace, computer services, information, and office and telecom equipment). It is also consistent with the empirical evidence of Branstetter *et al*. (2007) suggesting that, owing to IPR reform, increased multinational activity in developing countries is sufficient to offset potential declines in imitative activity, resulting in an overall enhancement of industrial development in the South.

Vicious (or no virtuous) circles: The case of low-income countries

This is not the case in low-income countries, where the empirical evidence suggests that the various channels by which countries are exposed to foreign technologies are far less effective:

- FDI remains at a very low level (less than 1% of GDP) and the share of FDI in capital formation is also low.
- The ratio of high-technology product imports to GDP is very low and the role in the world market for high-technology goods is marginal.
- A licensing-based strategy for acquiring technology to complement or substitute FDI may not be very efficient because of a lack of technological and legal capabilities and because markets for technology are less efficient when the transactions are between very heterogeneous players.

These countries have not been very successful in improving their absorptive capacity, so that the potential of foreign technologies to improve the domestic economy is not fully realised. Their use of foreign technologies is described in terms of a "passive approach and limited effort to leverage the technology imported by foreign firms operating on their soil" (World Bank, 2008).

Not only have FDI and trade not greatly raised these economies' exposure to foreign technology, the extent to which they have benefited from this exposure has been limited by weak capabilities. As a result the gap between middle-income and low-income countries is widening (in terms, for instance, of the share of capital goods in GDP). What works in middle-income countries – foreign technologies are massively adopted through FDI and trade and spill over to the rest of the economy – does not work well in lower-income countries.

This leads to what is the main message of this chapter: different countries have different challenges in terms of innovation and knowledge policy. In an emerging, developing country context, the challenge appears directed towards the traditional "backing winners" industrial science and technology policy, and it draws attention to the importance of engineering and design skills and of accumulating "experience". In a least developed country (LDC)[3] context, characterised by "disarticulated" knowledge systems, the policy challenge is much more complex (Soete, 2009).

The need for technology transfer as a principal objective

A second, more precise, issue is the kind of technology transfer that should be supported and promoted in these countries. FDI as a valuable vehicle for technology transfer and spillovers in middle-income countries (Blomström and Kokko, 1998) exhibits some shortcomings that are likely to be amplified in low-income economies.

The issue is whether the incentives of the foreign investor and the importing country are really aligned when the latter is a low-income economy (alignment of incentives is the advantage most frequently advanced when the TT is a joint product of another economic operation). Foreign investors primarily want to succeed in putting a plant into operation and keeping it running for a certain period of time. If incentives are not properly balanced between the need to make the industrial facilities operate efficiently and the need to transfer learning and knowledge to local workers and engineers, the foreign investor is likely to devote insufficient resources and time to the learning process. The foreign investor is also likely to do most of its R&D in its home country, thereby preventing the development of core technologies in the host country.[4]

The nationals of the importing country need to absorb the whole range of capacities and capabilities (including tacit knowledge). But what matters most for the foreign investor is the success of the industrial operation, not of the transfer in itself. For example, Choii *et al*. (1994) argue that foreign investors have little incentive to take the initiative in shifting responsibility for technological adaptations to local suppliers or staff. If the replacement of expatriates is unnecessarily delayed, however, this prevents the learning process from fully taking place. This is a clear case of unbalanced incentives between the need to make the investment operational in the short term and the need to transfer the technology. In this case, TT becomes more a by-product than a joint product.

For low-income countries, the number, scale and sectors of technology transfer cannot be allowed to depend *only* on general economic operations such as FDI or infrastructure construction; neither can they take the form of market transactions alone (*e.g.* licences). In such cases, the circumstances and conditions prevailing in low-income countries imply a suboptimal level of technology transfer in relation to these countries' needs.

What model of innovation for the least developed countries? The importance of local innovation and local spillovers[5]

In LDCs it is important to support certain types of innovation as engines for growth. Otherwise, local needs and local markets may not necessarily be well served and more effective government incentives may be required.

In terms of their innovation capacities LDCs are characterised by two features: they are small countries (in terms not of the size of GDP but of the relative size of the relevant sectors of the economy, those that would potentially benefit from technological spillovers from innovation) and they have weak absorptive capacity. This entails both a difficulty and a risk: the difficulty of integrating spillovers that originate elsewhere; and the risk that the export-oriented R&D they do will spill out of the country and benefit external firms and consumers rather than the local economy. For the LDC, the balance of knowledge and information spill-in and spill-out may therefore be negative.

Therefore, even if an LDC may benefit from "plugging" some of its activities into the global market, this should not preclude support for locally oriented innovation, which can be critical for growth and social well-being. The development of capacities to produce locally oriented innovations allows the country to develop absorptive capacity, but at the same time locally generated spillovers from those efforts may diffuse away from the local economy.

Innovation should take place over the whole spectrum of economic activity, across sectors (not just in high technology) and types of innovations (not just formal R&D). In LDCs it is incremental, cumulative and mostly informal (without R&D), mainly in "traditional" sectors or in services that do not qualify as "high technology". Although these innovations mostly take place in low-technology activities, they generate local spillovers and will ultimately affect the productivity of a wide range of sectors in the local economy.

Given that information and communication technology (ICT) is considered the major general purpose technology (GPT) of our time, ever broader segments of a less developed country's economy should adopt ICT and "invent" new applications for ICT that increase their productivity. A GPT fosters economy-wide growth not simply and not mainly through innovation in the GPT itself; rather, growth will occur when a wide range of sectors adopt the GPT and improve their own technology. The key issue, therefore, in "secondary countries" (those not at the GPT frontier) is how to allocate R&D and other innovative inputs so as to leverage the growth potential of the prevalent GPT. The key point is not that ICT in and of itself causes growth, but rather that "innovation complementarities" in adopting sectors need to materialise for economy-wide growth to take place. These innovation complementarities (adoption, local innovations in traditional sectors) may be seen as less innovative and therefore may not be deemed as worthy of support or encouragement. Yet they ultimately constitute the key to economic growth.

In LDCs, innovation policy should pay attention to these issues. It should not aim just at increasing total R&D, but do so in a way that encourages local innovation and local spillovers rather than global R&D and external leakages, that develops absorptive capacity, and that ultimately affects the productivity of a wide range of sectors in the local economy.

A new framework

David and Metcalfe (2008) distinguish between the knowledge ecology and innovation systems. On the basis of this distinction they find that the innovation policy response has two related branches which can be used to explore problems relating to innovation in developing economies. To this framework a third dimension is added here which involves the search for the areas in which a country should try to position itself in the knowledge economy.

Knowledge ecology

The knowledge ecology is defined as involving all kind of institutions and organisations dedicated to the production, dissemination and utilisation of new and "superior" knowledge. The knowledge ecology encompasses not only the activities of R&D institutions but also the more applied research activities of public and private firms, as well as programmes for educating and training the technical workforce. The knowledge ecology determines the conditions of existence of knowledge. However, it is not itself a

system of innovation. The role of the knowledge ecology is to form the research capabilities and the knowledge base for innovation. It provides the basis on which particular innovation systems focused on particular problems can either self-organise or, failing this, be encouraged to form through specific policy interventions.

Systems of innovation

A system of innovation cannot be taken for granted. The defining characteristic of a system of innovation is that its components are connected. When they are not, there is an ecology but not a system. Therefore, systems of innovation emerge as the elements of the ecology interact to further the innovation process.[6]

The notion of a single, monolithic and highly durable innovation system is a deceptive intellectual construct. It is far better to recognise the many ways in which research organisations, entrepreneurs, firms, users and economic institutions interact to further the innovation process. In a healthy industry and service economy, there are countless numbers of specialised innovation systems generated at the micro level, systems that are born and decay as new innovation problems are raised and solved.

Discovering the relevant areas for advancing science and technology

Finally, countries need to develop a vision of where they want to be positioned in the knowledge economy and implement a strategy. Some years ago, Enos (1998) described the shift in many LDCs in the locus of decision making concerning the future direction of their economies from local authorities to foreign assistance bodies. As a consequence, the science and technology areas to be pursued are chosen primarily for the effects on developed countries. It is instead crucial for LDCs to decide for themselves which science and technology areas they should seek to develop. They need to engage in a search process, involving entrepreneurial trial and error as well as public policy to create incentives for entrepreneurs who take the risk of engaging in new activities. It may be that the most important innovations in LDCs evolve from the process of discovering what the country should do in terms of specialisation in industry and services (Hausman and Rodrik, 2002).

Knowledge policy

The aim of knowledge policy should be to improve the chances of forming innovation systems from the knowledge ecology. The problem is largely one of barriers and incentives to collaborate in solving problems in the area of innovation. Seen from this perspective knowledge policy has three dimensions:

- Responsibility for encouraging entrepreneurs and institutions to engage in a trial and error process to discover where to allocate resources to develop capacities.
- Responsibility for undertaking to ensure that the ecology of research organisations and knowledge is sufficiently rich and diverse to cover all areas of relevant knowledge by research expertise (at country or regional level).
- Responsibility for framing the institutional architecture and the structures of regulatory constraints and rewards available to present and future researchers, entrepreneurs, managers and other stakeholders so as to allow sufficient flexibility and mobility to stimulate and reinforce connections and transform the knowledge ecology into adaptive innovation systems.

While the second responsibility involves some top-down initiatives (creation of new disciplines, establishment of new institutions), the first and third deal with the creation of the conditions that can facilitate bottom-up and decentralised processes of discovery and innovative activities.

Discovering the relevant areas for science and technology capacity building

Determining the kind of knowledge base a particular region or country must build in order to define its growth strategy is a key issue but a difficult one. It must be emphasised that this should be based not on a bureaucratic logic of industrial planning but on a research process of the entrepreneurial type, one in which entrepreneurs play a central role. Decision makers should limit their interventions to three aspects of the process: helping entrepreneurs of a rather special type (see below); identifying complementary investments (human capital) and facilitating the co-ordination mechanisms which allow a regional system to switch collectively to the selected specialisations; and cutting investments which turn out to be inappropriate but were supported as a result of the search process.

The search for the right science and technology areas is an entrepreneurial process

This involves a particular learning process, which has not so far received very much attention from economists. It consists of discovering the areas of research and innovation in which a region can hope to excel. It depends primarily on the entrepreneurs who are best placed to discover these specialisations. This involves a process of discovery since the production functions of the different types of innovation and invention are not common knowledge.

According to Hausman and Rodrik (2002), a key role for entrepreneurs in LDCs is to learn what the country is good at producing. For an LDC, there is great social value in discovering this since this knowledge can orient the investments of other entrepreneurs.

This activity poses a problem for public policy. The discovery of pertinent areas of specialisation has high social value since this knowledge will define the direction of company investments and the projects of research organisations. But the entrepreneur who makes this discovery will only be able to capture a very limited part of his/her investment's social value since, by definition, other entrepreneurs will swiftly move into the area. There is consequently a risk that too few entrepreneurs will "invest" in the discovery process.

Insofar as the process of finding appropriate areas for a given region implies investment, and as the return on this investment cannot be completely appropriated by those who discover them, this raises an incentive problem, which apparently cannot be resolved by resorting to intellectual property. The basic discovery concerns a field of research or type of innovation in which the region could take the lead. This type of discovery is not normally subject to legal protection, whatever its social return. Public policies thus have an essential role to play in encouraging entrepreneurs who invest in this particular discovery process but will not be able to use the usual legal protection mechanisms to capture a large proportion of the social return on their investments.

Opportunities for everyone?

One key aspect of the scenario developed above is that it offers strategies for everybody. Certain advanced regions are well placed to try their luck in the area of general purpose technology production. Many others are in a good position to develop applications of these GPTs for economic activities which are important for the region in question: biotechnology applied to the exploitation of maritime resources; nanotechnology applied to wine quality control, fishing, cheese and olive oil industries.

Major innovations are the result of the invention of a GPT and of the ensuing successive technological generations but myriads of equally economically important innovations result from the "co-invention" of applications. A GPT is in fact distinguished by its horizontal propagation throughout the economy and the complementarity between the invention and the development of applications. These complementarities are fundamental. In the terms of the economist, the invention of the general technology extends the frontier of invention possibilities for the whole economy, while development of applications changes the production function of a particular sector. Application co-invention increases the size of the general technology market and improves the economic return on inventive activities relating to it. There are therefore dynamic feedback loops: inventions give rise to the co-invention of applications, which in turn increase the return on subsequent inventions. When the process evolves favourably, a long-term dynamic develops, consisting of large-scale investments in research and innovation which give rise to high levels of social and private marginal rates of return. This dynamic may be spatially distributed between regions specialised in the basic inventions and regions investing in specific areas of application.

Most of the recent productivity gains from information technologies thus result from applications in certain sectors but previously resulted from generic inventions. This goes to show that there are indeed strategies for everyone: some key regions will play a role in the production of these technologies, a role that will be all the more prominent as these regions will benefit from more powerful agglomeration effects. A great many other regions must develop their knowledge bases at the intersection of a GPT and one or several sectors of application.

These regions must however forge strong links with one of the regions that supply the generic knowledge, so that the application co-invention processes are permanently revitalised by the dynamic of the generic invention. These connections are in theory facilitated by the existence of externalities between the two regions, but additional incentives are also necessary.

"Beware of investing in things that can move"

The search for the right areas – if successful – is likely to help countries to manage the brain drain issue somewhat better. The knowledge resources produced by the region, thanks in particular to its higher education, professional training and research programmes, constitute "co-specialised assets" – in other words the regions and their assets have a mutual need of each other – which reduces the risk of seeing these resources go elsewhere. It is worth recalling the old maxim of the economics of development: "Beware of investing in things that can move!" They will more logically circulate among the small number of regions that seek to advance science and technology in the same areas.

The particularisation of regional and/or national knowledge bases will prevent the global market for the highly skilled from becoming a mechanism for "draining" certain territories and will instead encourage the emergence of a geographically distributed system of research capacities.

Improving the knowledge ecology

The fundamental policy question here is whether the knowledge ecology is sufficiently rich and diverse to cover all relevant areas of knowledge (given the areas of specialisation) and to ensure that the processes that are critical for advancing knowledge (codification and cumulativeness) can develop.

The four functions of the knowledge ecology

The knowledge ecology encompasses the set of institutions that enable access, production, transmission/use and measurement of knowledge for learning and innovation. This section briefly presents the main issues for each of the functionalities of a knowledge ecology in a developing economy.

Access to new knowledge, once it has been produced, has a particular meaning in a developing economy context. New knowledge that is essential in both the developed and developing worlds is produced for rich markets but is not accessible to LDCs as very few people (firms) can afford to pay the price for patented knowledge. Typically this is the case of the GPT-related knowledge that forms the building blocks for further development of applications. The crux of the issue is that this knowledge must be sold in the developed world at a price that provides a return to R&D, while being made available at or near marginal cost in poor countries. The first issue is, therefore, the question of efficient distribution (optimal use) of existing knowledge, given its economic nature as a semi-public good. Since the marginal cost of its reproduction is negligible, prices should be negligible. However the production of knowledge often entails very high fixed costs which need to be recovered; otherwise nobody would commit the necessary resources and effort. The obvious solution here is "Ramsey prices" – a price discrimination scheme that maximises allocative efficiency in situations where some properties of the good considered (here the knowledge) make "price equal to marginal costs" unprofitable (Doyle, 1997). Other mechanisms are also possible. This issue of access is affected by the central role of IPRs in the current economics of technology transfer. Because patents allow inventors "above marginal cost pricing" and the system of intellectual property protection imposes its rules everywhere, new mechanisms and institutions are needed to maintain access to essential knowledge both for passive consumption and for learning and innovation.

The production of the knowledge and technologies which are needed in developing countries but have no market in the developed world raises a second issue. In this case, differentiated pricing will not work, because there is no rich country market in which to recover the cost of R&D. Pricing in developing countries at levels that would recoup such costs is not feasible because incomes are too low to generate adequate demand. In such cases, incentive mechanisms other than intellectual property may be needed. These include mechanisms and instruments to encourage governments and firms to develop research capacities and to create conditions for low-cost research activities within the country. While IPRs are a not a central issue here, the creation and development of a legal framework to create an "information commons" and to promote open source projects (an

IP-free zone in which knowledge and information are freely available and easily accessible) are of critical importance.

Transmission and use of knowledge is the third function. At this point, it is perhaps necessary to recall that "knowledge" as such – and the institutional framework devised to "optimise production and access" are almost useless in the absence of some other critical resources. As Machlup (1983) wrote: "the use of knowledge always complements the use of other resources, such as labor, material or, at least, user's capabilities and time. One cannot use knowledge without something else, and the complementary input may be scarce and valuable.... We have the knowledge to carry out irrigation projects in developing countries, but each of these programs would require additional scarce resources." In other words, the proposition "knowledge is available at zero marginal cost" does not imply anything about the cost of using the knowledge. Very often knowledge is usable together with resources available only at positive, and often very high, cost. For example, to be used effectively, knowledge needs educated people. Efficient processes and mechanisms for accessing knowledge cannot do the job alone. Resources such as human capital, physical infrastructure, the rule of law and service delivery infrastructures are also essential.

For instance, the building blocks of ICT technologies that are made available through various access mechanisms can lead to the co-invention of new applications in ways that increase productivity in traditional sectors. However this will only happen if infrastructures and enabling conditions for entrepreneurial activities (including human capital) are available in the developing economy. Knowledge that already exists in the country itself – traditional knowledge and know-how, natural substances – requires legal infrastructure and domestic entrepreneurial capabilities to be transformed into an economic asset that will contribute to growth and development.

Measurement is the final key ingredient of the knowledge ecology. Without measurement activities, the production of indicators and the regular collection of systematic data, the knowledge ecology is hardly visible and policy makers are unable to track progress, assess structural transformations and compare performance. They will therefore abandon the field. Data and science and technology indicators are necessary to make the knowledge ecology more visible to policy makers who can then design innovative policy responses for science and technology issues (Gault, 2008).

In sum, the four main functional objectives to be achieved for the knowledge ecology in a developing country context are:

- optimising access to existing knowledge and technologies;
- allocating global and local resources to research capacity building;
- developing human capital – in the form of sophisticated users, entrepreneurs and highly skilled workers – for effective use of the new opportunities offered;
- measuring inputs, outputs and outcomes.

Forming research capabilities and the knowledge base for innovation

The development of research capacities "at home" is of course a central issue for the development of the knowledge ecology. It raises both quantitative and qualitative challenges.

The building and expansion of a strong public research sector is an issue that must be addressed in ways appropriate to the stage of development. The arguments regarding the models of innovation to be supported in an LDC context can be used to stress the crucial role of public research organisations in the development of GPT applications: making generic knowledge locally applicable and "re-inventing" locally, to borrow from Stiglitz (2000), are crucial tasks. It is the local selection, assimilation and adaptation of knowledge that is central. Neither multinational corporations' affiliates nor local firms have the incentives and/or capabilities to do this.

In LDCs, the initial step is to build a research infrastructure through the creation and development of government laboratories in order to maintain some brains at home and support the specialisation of the entrepreneurial economy. The issue is different for catching-up countries, where the relative weight of government laboratories and research universities as R&D performers has to start shifting.[7] Table 5.1 shows, for example, the increasing percentage of scientific publications from universities as compared to other research institutions in South Africa.

Table 5.1. Distribution of scientific publications across institutions in South Africa, 1987-2003

Percentages

	1987	1991	1995	1999	2003
Universities	63.1	67.6	70.8	72.9	74.9
Institutes	12.1	12.4	11.0	9.9	9.3
Government	5.7	5.9	4.7	5.2	4.2
Hospitals	15.5	11.4	10.0	8.0	7.1
Business sector	2.4	2.0	2.4	3.2	3.1
	100.0	100.0	100.0	100.0	100.0

Source: Losego, P. and G. Goastellec (2008), "Nouvelle Afrique du Sud, nouvelle politique des sciences, nouvelles politique universitaire", *Les Cahiers de l'Observatoire*, No. 18, Université de Lausanne, based on SCI data.

Another fundamental issue for the improvement of the knowledge ecology in developing countries is the strong policy focus needed on allocating resources to the engineering sciences. Clearly, the willingness of firms to devote money to scientific research is very much influenced by the prospect of converting research findings into finished and marketable products. What matters for firms is that, whatever the specific research findings, an enlarged engineering capability will substantially increase the likelihood of being able to use them to bring improved or new products to the marketplace. Engineering sciences are also critical for ensuring that universities are responsive to the technological and scientific needs of industry.

Engineering sciences are a part of the knowledge ecology that will play a central role in animating innovation systems because their impact runs two ways. First, they create an impetus for engineers to systematically transform basic knowledge to improve products and processes. Second, the establishment of a new engineering discipline lays the basis for making scientific research profitable. Engineering disciplines involve not only fields related to the hard sciences (mechanical, electrical, computer, etc.) but also the social sciences – the so-called "service engineering" which deals with organisation and management practices.

As Henry Ergas[8] has shown, what really matters in innovation performance at country level is not the best shot but the weakest link. This is particularly true when the weakest link is engineering science.

The development of capabilities and absorptive capacity in the business sector is another key issue for the knowledge ecology. Capabilities are a matter of some consequence to the less (and least) technologically advanced firms (Enos, 1996). The most technologically advanced firms can profitably absorb new technological knowledge and subsequent improvements and undertake development to adapt the technology to specific conditions. They employ the skilled persons needed to appreciate and assimilate advanced technologies, and can draw upon their previous experience in carrying out successive tasks. Less advanced firms lack these prerequisites for technological progress: even if they draw upon outside suppliers for planning, design, engineering, construction and initial operation, they are likely to find themselves unable to operate the plant so as to exploit its full potential, let alone to make the mundane day-to-day improvements that markedly increase its performance. It may take all the technical and managerial resources of the less advanced firms to master the transferred technology and implement the necessary adaptations and developments. Mastering improvements as they come along may prove too great a challenge. Building the capabilities to enhance innovative capacities is therefore crucial. It points towards economic models of development that emphasise the accumulation of skills and learning capacities, rather than fixed assets or capital, for facilitating innovation and technical change. This, in turn, calls for an explicit and proactive human capital policy.

Human capital for innovation is a focal point in any knowledge ecology policy. Widely available skills are of course necessary for any innovation-based growth strategy to succeed. Basic skills are necessary for innovative ideas to arise in the first place, would-be innovators need advanced skills to search for and absorb the necessary information, and inventors typically need even more sophisticated skills to be able to tackle the technological and business-related problems that arise along the way. Skills in this context thus mean a wide spectrum of capabilities to be acquired both through formal education and learning by doing (Trajtenberg, 2009). Two key competences – literacy and learning to learn – may be considered essential in any country which is challenged by the task of advancing science and technology in certain key areas.

Literacy is not only a precondition for using knowledge as consumption capital. It is also important for learning about advances in knowledge and innovation. This point was made initially by the 1964 Nobel prize-winning economist T. Schultz, who explored an apparent puzzle in developing economies. In some agricultural societies, persons who could read and calculate produced more crops per acre than persons who were illiterate. In other societies, literacy made little difference in how much persons grew per acre. Schulz solved the puzzle by explaining the importance of the pace of change. Where farming techniques had not changed for generations, techniques were passed down orally from generation to generation. In these traditional societies the economic payoff to literacy and math skills was extremely modest. In other societies, "the green revolution" in seeds and fertilisers was rapidly changing farming techniques. Here, reading was important to understand the directions that accompanied the new inputs, directions that were often very different from those for applying traditional inputs. The ability to measure accurately was important as well, since the payoff to the new techniques often depended on the spacing of seeds and the amounts of fertilisers applied at specified time.

Learning particular routines or skills is not the same thing as "learning to learn". As Enos (1996) observed, mastering a given state of the art is not enough; what is critical is to master a progressive state of the art. In the knowledge economy, the process is never-ending: no sooner have workers mastered one state of the art than they must begin to master its successor. Improvements may occur so rapidly that once workers have absorbed the current changes, the next set is already upon them. In a context of such rapid change, learning to learn or meta-learning provides workers with the capacity to transfer the skills acquired in formal education to a wider class of learning situations.

In this respect, policy requires a two-pronged strategy, consisting of the supply of the traditional public good type of education and skill formation, on the one hand, and ensuring the responsiveness of vocational and advanced skills supply, on the other. In particular, vocational schools, training programmes, colleges and universities should be made highly responsive to shifts in the demand for skills; policy has to ensure that "endogeneity kicks in" (Trajtenberg, 2009).

Building systems of innovation from the elements of the knowledge ecology: Barriers and incentives

To form a system of innovation the relevant organisations and individuals have to interact in ways that help to solve innovation problems. Systems depend on connections (interactions) and cannot be described or understood simply in terms of their components. So, the policy issue concerns the areas of the knowledge ecology in which connections have to be stimulated to transform the ecology into an adaptive innovation system and how to frame the institutional architecture and the structure of rewards so that interactions and the formation of multiple systems of innovation will occur. For reasons of space, the discussion is limited to two connection processes of particular relevance for innovative activities in an LDC.

Technology transfer and diffusion between the North and the South: Who should be connected?

A specific characteristic of developing countries is that the connections cannot be limited to the national knowledge ecology, as it is incomplete. The connections must therefore link elements of the national knowledge ecology to foreign sources of knowledge and technology. This is likely to happen through technology transfers between firms based in developed countries and local entrepreneurs operating in the developing world.[9]

As noted earlier, countries that are still trapped in a low-level equilibrium, with little exposure to foreign technologies and poor absorptive capacities, should not rely only on FDI and trade to ensure proper exposure to foreign technologies. TTs are needed as a principal objective (not just as a joint product or a by-product of FDI). In this case, the incentives are shaped by the cost and benefits of the TT only. In other words, incentives cannot be combined with other intervention is support of, for example, FDI. When the TT is a principal objective there is no other economic operation to "help", and the prospect of returns solely on the TT operation must be sufficiently attractive to encourage the technology holder to enter the transaction. This means that host governments will often have to provide additional incentives.

Should governments encourage any "model of firm" in both countries to enter this kind of transaction, given the constraints in low-income countries (disarticulated system, weak capabilities, low affordability among potential buyers)? If the answer is in the affirmative, government policy should identify those firms and enrol them in TT projects.

Demand for technologies

On the demand side, the importance of innovations that target local needs and potentially generate spillovers that can be captured by the local economy has been emphasised. TTs in these areas should be encouraged so as to help entrepreneurial efforts meet local needs on local markets. The social gains of serving the local market in regard to consumer surplus may be very large, for example in the area of medical care. Moreover, local spillovers may in some cases be more significant and more widespread when innovating for the local market, if only because of the demonstration effects.

Supply of technologies

On the supply side, Arora *et al*. (2001) develop interesting case studies of specialised technology suppliers in the chemical industry. They look at how the development of specialised upstream technology suppliers in developed countries improves technology access and lowers investment costs for downstream firms in developing countries. Testing this idea, they show that there are more investments in chemical plants in less developed countries when a large number of technology suppliers operate in developed countries. According to the authors, what matters is the vertical organisation of the industry in the developed world: investment takes place earlier and more rapidly than if developing countries had to rely solely on chemical producers in the developed world to transfer the technology. The mechanism is quite simple: specialised suppliers develop technological capabilities which are then sold to downstream firms. Because the expertise and the technologies developed are process- and not location-specific, they can be made available to downstream firms in other countries. Moreover competition between suppliers implies that the expertise and the technology will be made available at prices close to the marginal cost of transfer. The economic logic of this story is therefore that the industries or countries that emerge earlier pay the fixed cost of developing the technology, while later industries or countries pay only the marginal cost.

As a consequence of a certain stage of vertical disintegration of the industry, the presence of independent suppliers that do not produce the downstream product is important: downstream producers (chemical firms) are less likely to sell technology to potential competitors (located in less developed economies). Thus, specialisation and division of labour can benefit industrial growth, because of the ability of independent suppliers to operate TTs while not undermining their competitive position.

The need for specialised agents to facilitate public-private partnerships

The complexity and difficulty of the TT operations supported and encouraged by governments of rich countries make it necessary to use "specialised agents" with experience in TT operations.[10] Such agents specialise in linking public donors, private firms and local entrepreneurial activities to ensure the effectiveness and efficiency of the operation.

The specialised agent compensates for critical deficits of institutional mechanisms both in less developed and developed countries in order to address problems arising from the management of a TT as a principal objective.

Public research organisations and industry

Strong connections between the public research sector and local industry are of critical importance. In an LDC, there are no large companies acting as "anchor tenant", that is to say, with high absorptive capacity and incentives to be connected, or networks of highly sophisticated small and medium-sized enterprises with a similarly high level of capacities and incentives to collaborate with public research organisations. Public research organisations have to cope with a system of small farmers or small entrepreneurs with very little absorptive capacity. Tacit knowledge is hard to transfer but so are the codified forms which disseminate more easily in an advanced country through archival publications and other impersonal broadcast media. In an LDC, the codified and tacit knowledge and information generated by public researchers has to be transported and delivered to the sites of innovation. There is no "self-service arrangement"; rather, what is needed is a "*service à la table et à la carte*".

Building networks is, therefore, the key objective. However, in much policy discourse, invocation of the power of networks is essentially a mantra. Yet the now-fashionable "network" metaphor does not represent the same thing as a well worked out economic model from which one can legitimately move, by way of institutionally grounded empirical inquiries, towards a fundamental reorientation of policies to encourage the local adaptation and distribution of knowledge to potential "clients".

In the case of agricultural innovation, the transferability of knowledge from public research organisations needs to be supported by the development of extensive networks of publicly funded research stations with advisers who reach out to small farmers (Collier, 2008). Organisational models such as technology consultancy centres or technology platforms are important for building effective interfaces between R&D activities in public research organisations/universities and local demand for technologies and knowledge. These interfaces are particularly useful when they involve available expertise from universities and other public research organisations for consultancy work; the transfer of technologies for industrial development through the establishment and co-ordination of campus-based production units; and the use of such centres as a clearinghouse for technical information and services to and from the public research organisations (Enos, 1998).

Conclusion

Novel ways of conceptualising innovation processes and systems are only interesting if they lead to new insights. The framework presented – involving a key distinction between the knowledge ecology and systems of innovation – defines three categories of policy responsibilities:

- One involves supporting the process of entrepreneurial search and discovery of relevant areas for advancing science and technology.
- Another involves developing the knowledge ecology to ensure that the ecology of research organisations and knowledge is sufficiently rich and diverse and that research expertise is available in all areas of relevant knowledge. Improving the quality of the knowledge ecology primarily involves the formation of research capabilities and the knowledge base for innovation.

- A third involves the responsibility for improving the chances of forming innovation systems from the ecology, which entails dealing with barriers and incentives to collaboration in solving innovation problems.

The organisation of the ecology, the areas of science and technology specialisation, and the incentives and barriers for co-operation among different elements in the pursuance of innovation are central issues in the design of an empirically and analytically informed innovation policy in less developed economies.

Notes

1. Here a knowledge ecology consists of the institutions and organisations dedicated to the production, dissemination and utilisation of knowledge. It is distinguished from an innovation system in that there are weak or no linkages among institutions and organisations and with other actors in the system.

2. When TT is referred to as a joint product or by-product, it relies on the accounting definition of these concepts. Joint products are two products that result simultaneously from one shared cost, and they have comparably high (sales) value. By-products are produced along with a main product. The latter constitutes the major portion of the total (sales) value. By-products have a considerably lower (sales) value than the main products. These concepts are applied to TTs, substituting "perceived value to technology holders" for "sales value".

3. A least developed country (LDC) is a low-income country which faces severe structural handicaps to growth. The United Nations list of LDCs may be found at: *www.un.org/esa/policy/devplan/profile/ldc_list.pdf*.

4. See Enos *et al.* (1997) for a development along the same lines applied to the special case of Africa.

5. The discussion in this section draws heavily on scholarly exchanges and many discussions with M. Trajtenberg, whose views on these issues for LDCs can be found in Trajtenberg (2009).

6. S. Metcalfe made this point very forcefully during the January 2009 workshop.

7. The centrality of government laboratories is appropriate at a certain stage of economic development when the main challenge is to build a science and technology infrastructure and the fastest way to do it is to create these "mission-oriented" institutions. However, when those countries are catching up, the need for more resources in research universities is obvious: research universities become central for generating externalities in the form of human capital and basic research which have the status of "joint products" (and give rise to economies of scope and internal spillovers) while government laboratories break the intimate relations between research and higher education and only provide a small fraction of the total amount of positive externalities that research universities are able to provide.

8. Henry Ergas is an influential economist who has worked at the OECD.

9. See Chapter 6 in this volume for an overview of the economic opportunities offered by North-South technology transfers and an analysis of the conditions required to ensure effective and efficient modes of knowledge sharing.

10. TT is a decreasing cost activity (Mansfield, 1982; Teece, 1997): the more extensive the experience previously acquired by the organisations involved in the process, the lower the transfer costs in relation to total project size.

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Chapter 6

Facilitating North-South Knowledge Sharing: Conditions for Enhanced Knowledge Flows

by

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This chapter discusses framework conditions needed to enhance North-South knowledge flows through the transfer of intellectual property, trade and foreign direct investment (FDI). These conditions include mechanisms for investing in human capital, outward-oriented trade policies and FDI policies that do not discriminate against local firms. As well as investing in education, science and technology, and R&D to enhance absorptive capacity for knowledge transfer, needs are identified for technological infrastructure, socioeconomic infrastructure, productive capacity and a national orientation, including transparent regulation, low risk and support for entrepreneurship. Specific incentives for FDI are also discussed.

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Introduction

Most of the world's commercial technology is produced by multinational corporations (MNCs) in developed countries. Most economies, developed as well as developing, rely to a great extent on these companies for the development of technology, productivity and real income. Some of the technology flows that occur take the form of arm's-length sales of licences, royalties and patent rights, but an even larger share of the aggregate technology flows takes place through trade in other goods and services and foreign direct investment (FDI) flows. Trade relations contribute to technology diffusion both as a result of the knowledge flows that accompany long-term trade relations, and because much technology is embodied in traded capital goods. FDI contributes directly to international technology diffusion, as foreign MNCs transfer technology to their foreign affiliates, and indirectly, as the technologies and practices employed by affiliates are diffused to local firms in the host countries.

The objective of this chapter is to discuss the broad framework conditions necessary to facilitate these kinds of international technology flows. It looks first at the market for technology, and then summarises some of the evidence of knowledge flows through international trade and FDI. Next, it asks what is required in terms of policy to enhance these knowledge flows: the main factors are arguably related to investments in human capital, outward-oriented trade policies, and FDI policies that do not discriminate against local firms. A brief conclusion follows.

International technology flows: A review of the evidence

The technology market

Unlike the markets for most physical commodities, the technology market is difficult to describe and analyse. The main reason, of course, is that "technology" is an inherently abstract concept and therefore difficult to observe and evaluate. None of the available proxies for technology and technology production – such as R&D expenditures, numbers of new patents, payments for licences and royalties, flows of knowledge-intensive services, stocks of capital equipment, and so forth – provides a perfect measure of technology. Simply put, knowledge and technology can take many forms, embodied as well as disembodied. Consequently, there are many different channels for transfers of technology from producers to users. To add further complications, markets for knowledge and technology are generally not very efficient. The reason is that buyers and sellers of technology often fail to agree about mutually acceptable prices. While potential sellers of technology may well have a good sense of the value of a specific technology, it is hard for a potential buyer to estimate the value without understanding the specifics of the technology. If the potential buyer is given the information necessary for assessing the value, he or she may be unwilling to pay the price. Having received all the relevant information, the buyer has already absorbed the relevant knowledge, whether or not a formal sale is agreed: it is difficult to guarantee "unlearning", *i.e.* ensuring that none of the knowledge transferred to the potential buyer is ever used if the technology sale falls through. While it might theoretically be possible to write contracts that reduce the risks borne by technology producers, transaction costs are likely to be very high. Hence, producers of technology are often more likely to "internalise" it (by engaging in vertical integration and using the technologies under their own ownership and control) than to sell it in arm's-length markets (Grossman and Hart, 1986). In fact, these imperfections in

technology markets are often seen as the main reasons for FDI and the existence of MNCs (Caves, 1996).

Against this backdrop, it is perhaps not surprising that more emphasis has been put on measuring inputs into technology production than on formal transactions on the technology market. In particular, attention has focused on expenditures for research and development (R&D) as an indicator of technology production, although this is only one part of the aggregate production of knowledge and technology in any society. Higher education, software production and investments in machinery and equipment are other important parts of total knowledge production.

A look at global investments in R&D shows that the most notable feature is its concentration in a few developed economies. OECD (2008) reports that the world's total R&D expenditures in 2005 amounted to just below USD 1 000 billion, adjusted for purchasing power. One-third of this was accounted for by the United States, with the EU accounting for one-quarter of the total and Japan adding 13%. Taken together, the share of the OECD reached nearly 80%, with most of this registered by only five countries – in addition to the United States and Japan, they are Germany, France and the United Kingdom. The only non-OECD countries with notable shares were China (with nearly 12%) and India, Brazil, Russia and Chinese Taipei (with a combined 6%). A similar picture applies for research and higher education, as well as patent applications, one of the few tangible (although very imprecise) measures of the results of investments in R&D. One of the few areas in which the dominance of the large OECD countries has been diminishing is the export of high-technology products, as China has rapidly captured a large market share. Between 1999 and 2005, China more than doubled its market share in world exports of high-technology manufactures; its share grew from 8% to 19% and it established itself as the world's largest exporter in that product category (NSB, 2008).

Apart from a strong concentration across countries, there is also a significant concentration of technology production in a small number of industries and companies headquartered in the OECD area. The industries with the largest R&D expenditures are computers and electronic products (including telecommunications equipment), chemicals (including pharmaceuticals), computer-related services (including software), aerospace and defence manufacturing, R&D services, and automotive manufacturing (NSB, 2008). In each of these industries, significant shares are held by a few very large producers. In 2004, the top 25 R&D-spending corporations invested about USD 175 billion, more than what the entire non-OECD world spent on R&D (NSB, 2008). Moreover, a significant share of the R&D performed outside the leading OECD economies is actually controlled by MNCs headquartered in countries such as the United States, Japan, Germany and the United Kingdom. Academic knowledge production has a similar concentration in a few of the larger OECD countries.

Hence, developing countries, as well as smaller OECD economies, are to a great extent dependent on the knowledge created in the larger OECD countries. This chapter focuses on FDI and trade as channels for the diffusion of knowledge and technology from the main research producers to the rest of the world. There are other important diffusion channels, but they are only discussed parenthetically here. The movement of people is perhaps the most important channel for knowledge flows in an historical perspective. The mobility of students and researchers across international boundaries may be the most significant part of this today, but the mobility of entrepreneurs has been highly important in the past. There are also less formal types of knowledge flows that emerge when people move across international borders for business and tourism. The mass media play an

important role, diffusing information about products, processes and technologies through newspapers, books, TV and radio broadcasts, and, increasingly, through the Internet and other telecommunications channels.

Although trade in goods, formal technology transactions, and FDI are conceptually separate, they are difficult to keep apart in any empirical discussion. Since most commercial technology is produced by MNCs, it is clear that MNCs will also figure prominently in international trade in goods as well as technology. The scattered data that are available on MNC participation in licensing and goods trade are interesting because they confirm that MNCs are the main sources of technology, but also because they indirectly introduce FDI into the picture. MNCs control the supply of technology by virtue of their R&D efforts and their ownership of proprietary technologies, but they also account for a significant share of demand, via their foreign affiliates. This is most apparent for transfers of "disembodied" technology captured by data on trade in royalties, licences and patent rights. About three-quarters of the registered payments to the United States for technology sales in 2005 were made by foreign affiliates of US firms (NSB, 2008). Similar ratios of intra-firm technology payments have been reported for other major technology producers such as Germany and Japan in the 1980s and early 1990s (Kokko, 1992).

The intra-firm character of the technology transfers that take place through trade in capital equipment and other products is less apparent, but still distinguishable. What we know about MNC involvement from statistics on goods trade is that between 70% and 80% of the goods exports of both the United States and the United Kingdom – the main suppliers of embodied technology together with Japan and Germany – are accounted for by MNCs. Moreover, a significant share of the exports and imports of the major home countries (perhaps up to one-third overall, and more for complex and technologically sophisticated goods that supposedly embody more technology) flow between MNC parents and affiliates. A very important part of all formal technology transfers are, therefore, closely tied to FDI.

Recognising that it is probably impossible to keep trade and FDI completely separate, the next section looks at the empirical evidence on technology diffusion and knowledge flows generated through international trade. Thereafter, the focus shifts to the technology flows that can be more directly related to the foreign operations of MNCs.

Technology diffusion and trade

The idea that knowledge is a public good that can diffuse from the producers of knowledge (or the investors in R&D) to other actors in the economy is an important component of endogenous growth theory (Grossman and Helpman, 1991). In addition to the return from their own R&D, which is eventually likely to exhibit diminishing returns, the investors will also benefit from knowledge spillovers from the existing stock of knowledge, which is growing over time. A consequence of knowledge spillovers is that the economy's growth rate may not necessarily fall as the stock of knowledge grows (as neoclassical growth theory would assume) but may instead be sustained at a permanently high level.

These knowledge spillovers also have an international dimension: knowledge created through R&D in one country can diffuse to other countries. The first empirical studies on international R&D spillovers in the endogenous growth tradition focused on international trade in intermediate goods as the main channel for international knowledge spillovers. By weighting measures of foreign R&D stocks with bilateral import shares, Coe and

Helpman (1995) examined how domestic total factor productivity (TFP) was affected by exposure to foreign knowledge through imports. Their results supported the idea that knowledge diffuses through trade: imports from countries with large knowledge stocks seemed to raise domestic productivity.

A host of earlier studies have discussed some of the processes that make traded goods effective carriers of technology and knowledge. Imports from R&D-intensive countries may prompt reverse engineering – the practice of taking apart and analysing products, to learn about the technologies embodied in them – which is often recognised as one of the main sources of involuntary technology dissemination (Zander, 1991). One of the few comprehensive quantitative assessments of the importance of imitation and reverse engineering was made by de Melto *et al.* (1980). They report that half of a sample of 280 significant innovations commercialised in Canada between 1960 and 1979 could be characterised as "imitations", and that more than half of these resulted from reverse engineering. Supporting these results, Mansfield *et al.* (1981) found that 60% of the patented innovations in their sample were imitated within four years. Kim and Kim (1985) also presented evidence of imitation and informal technology transfers in 42 Korean firms. Apart from reverse engineering, which essentially creates "unintentional" technology diffusion (from the perspective of the exporter), there are also processes which connect trade to intentional technology transfer. For instance, foreign exporters of sophisticated capital goods often have incentives to provide formal training in order to convince potential customers of the value of their products.

It is also possible that bilateral trade flows are proxies for other types of contacts that contribute to knowledge sharing. The seminal analysis by Coe and Helpman (1995) has therefore been replicated and developed by a large number of other authors. While several of these contributions seem to confirm the central role of imports as a vehicle for international knowledge flows (Lichtenberg and van Pottelsberghe de la Potterie, 1998, Keller, 2000), others focus on more precise measures of international trade or alternative channels for knowledge flows. For instance, one group of studies has argued that overall imports or even manufacturing imports are blunt proxies for technology flows, and that it is more appropriate to look at capital goods (Xu and Wang, 2000), machinery and equipment, particularly for North-South knowledge flows (Coe *et al*., 1997), or machinery alone (Mayer, 2001). Lumenga-Neso *et al.* (2005) point out that a bilateral trade relation not only gives access to the technology created through R&D in the trade partner, but also to all of the knowledge used in the trade partner, even if that knowledge may have been produced in some other country. Hence, previous rounds of imports (which have built up the total knowledge stock and the capacity to export) need to be taken into account. Edmonds (2001) argues that exports are more important than imports, although Keller (2004) downplays this by noting that there is little empirical evidence from micro-data analyses to support the hypothesis that learning by exporting is of great importance. The "conventional wisdom" in this line of research is increasingly that the export premium found in most firm-level productivity analyses is not a result of learning by exporting, but rather a reflection of underlying selection processes (Andersson *et al*., 2008). There are substantial fixed export costs that only the most productive firms are able to overcome. Instead, it is likely that unobstructed access to imports (including embodied and disembodied technology) is a prerequisite for successful export performance, and that liberal trade policies are important to maximise inflows of technology. At the same time, it is necessary to note that exports often result in formal and informal linkages with foreign customers and partners, and that these linkages are likely to be of importance for flows of information and knowledge. This is perhaps most

obvious in cases in which local firms exports as subcontractors or suppliers to foreign firms, and receive technical assistance in order to meet necessary standards of quality and other product characteristics.

An interesting recent addition to this strand of literature is Henry *et al.* (2009), who look not only at how international trade affects knowledge flows from North to South, but also how the ability of countries to make use of foreign technologies differs depending on the economic environment. Like Coe *et al*. (1997), they conclude that imports of machinery and equipment seem to promote North-South knowledge flows. Moreover, in their stochastic frontier analysis, they find that trade policy and openness seems to affect the efficiency with which foreign technologies are employed: more open and outward-oriented countries exhibit higher efficiency. Similarly, Keller (2004) has emphasised the importance of absorptive capacity (mainly in the form of human capital) for the ability of developing countries to access foreign technology.

Broadening the analysis beyond imports and exports, Gong and Keller (2003) and Keller (2004) stress the fact that several different mechanisms for technology diffusion are likely to operate at the same time. These include, for example, geography, communications patterns (such as bilateral language skills) and FDI. Lee (2005) notes that much of the knowledge produced through R&D is intangible, and should not have to be embodied in goods. As an alternative, he looks at the role of telecommunications networks (including the Internet) as channels of knowledge flows. The results suggest that these "direct" effects are more robust than those that require imports of intermediate goods. Focusing specifically on developing countries, Savvides and Zachariadis (2005) also find that the direct effects are strong in comparison with imports of capital goods and FDI. Several studies have concentrated on the R&D spillovers related to FDI. As Keller (2004) and Blomström and Kokko (1998) note, the evidence on the role of FDI appears to be mixed, with plenty of studies showing potential for substantial spillover benefits, but others finding no significant effects. This motivates a closer look at the role of FDI.

Before that, however, it is appropriate to comment on the quantitative importance of foreign R&D for productivity growth. Summarising the results from the literature on R&D spillovers, Keller (2004) notes that estimates vary widely depending on methods and country characteristics. In particular, country size seems to matter. In the larger OECD countries, the weights of domestic and foreign R&D appear to be biased in favour of domestic knowledge; in the smaller OECD countries, the pattern is the opposite. This is consistent with the assumption that there are important scale effects in R&D which benefit larger countries. For small countries, the share of domestic R&D in total productivity increases may be as low as 10%, with the rest accounted for by foreign technology. However, Keller also notes that developing countries may be in a somewhat different position. Although poor countries receive almost all of their technology from abroad – since domestic R&D resources are very small – it might actually be the scarce domestic R&D that is most important for growth. One reason is that much of the modern technology invented in the rich countries may be inappropriate for poor economies, because it is based on the assumption that labour is relatively scarce while capital is relatively abundant. Another reason is that domestic R&D capacity may be necessary to adapt foreign technology to local conditions: it may proxy the need for "absorptive capacity" noted by many authors.

Direct and indirect effects of FDI

As noted above, MNCs undertake a major part of the world's private R&D efforts and produce, own and control most of the world's advanced technology. These R&D and technology investments are heavily concentrated in a few home countries, unlike MNC investment, production and employment which are spread more widely across both industrialised and developing economies. Yet, the assets created through R&D are important ingredients in the foreign production activities of MNCs. One reason is that knowledge and other intangible assets are necessary to overcome the "disadvantages of foreignness" (Hymer, 1960/1976; Luo and Mezias, 2002). Another reason is that intangible assets are difficult to sell in arm's-length markets: a firm that wants to profit from its intangible asset outside the home market may find it is necessary to "internalise" the asset and exploit it through FDI (Cantwell, 1989; Caves, 1996). Hence, by establishing production outside their home countries, MNCs inevitably contribute to the international diffusion of knowledge.

However, it is not obvious exactly how MNC technology reaches new users in foreign markets, and what role MNCs themselves play in the process. FDI differs from arm's-length sales of equipment or licences in that the MNC chooses to retain the control and ownership of its proprietary technologies within the corporation. Is there any significant diffusion of technology to new users or is the MNC affiliate able to protect its technology from spreading to outsiders? And if technology spreads from the MNC affiliates to host country firms, what are the channels of diffusion?

An important finding in this regard is that there is a potential for spillovers of technology to independent local firms, which may be able to improve their own efficiency and productivity as a result of the presence of foreign MNCs. When foreign MNCs set up a subsidiary, they bring some of the firm-specific intangible assets that allow them to compete successfully with local firms. Some of these intangible assets – knowledge and skills related to product and process technologies as well as management, marketing and other aspects of firm operations – can be expected to spill over to local firms over time, as a result of employee turnover, linkages or simple demonstration effects. In fact, technology and productivity spillovers have sometimes been identified as the most important benefits of FDI, particularly for developing countries in which domestic technologies are less advanced than those developed and employed by foreign MNCs. Numerous econometric studies have demonstrated a positive relation between the presence of foreign firms and the productivity of local firms (controlling for various other firm and industry level determinants of productivity) and concluded that this is a sign of positive technology spillovers from FDI (Blomström and Kokko, 1998).

At the same time, there have also been a number of studies which cast some doubt on the hypothesis that all or most host countries may expect to benefit from technology spillovers (Aitken and Harrison, 1999; Görg and Greenaway, 2004). It has been particularly worrying that several studies of transition economies have not yielded any positive evidence of spillovers, considering the high hopes regarding international integration – the most obvious expression of which may be cross-border investment flows – expressed in many of these economies. For instance, Konings (2000) reports that foreign presence had no significant impact on the productivity of local firms in transition economies during the 1990s. Similarly, Damijan *et al*. (2003) conclude that FDI does not generate any positive intra-industry spillovers for domestic firms. The same conclusion is reached by Hale and Long (2007) in a study of Chinese manufacturing. However, Liu and Wang (2003) emphasise foreign presence, together with domestic R&D and firm size, as

the main factors contributing to TFP growth in Chinese industry, while Chuang and Hsu (2004) point to the importance of both international trade and FDI for domestic productivity. Moreover, the latter study highlights the importance of absorptive capacity, noting that spillover effects seem to be larger in sectors with small technology gaps. Liu (2008) also finds that there is a positive impact on productivity growth in local firms following FDI in their four-digit industry classification.

One reason for the mixed results could be methodological: most of the studies finding significant spillovers are cross-section analyses, whereas panel data models have systematically found less significant spillover effects. There is a possible bias in cross-section studies if foreign investors were mainly attracted to the industries that were most productive to begin with – this would give a spurious correlation between foreign presence and local productivity and lead to systematic over-estimation of spillovers.

Another source for a bias in favour of finding signs of spillovers is that cross-section analyses mainly reflect the long-term effects of foreign presence. If foreign MNCs have been present in the host country for a long time, it is likely that only the strongest local firms have survived the competition, while the weakest and least productive locals have already been forced out of business. This is consistent with a process in which some firms survive and grow strong because they are able to learn from the foreigners, *i.e.* because they benefit from spillovers, but the problem is that it is also consistent with other processes leading to productivity growth. For instance, the surviving local firms might have grown stronger because of their own R&D efforts or for other reasons that have nothing to do with technology transfers from foreign MNCs' affiliates. Still, if foreign entry triggers more competition, an econometric analysis would suggest that there is a positive relation between foreign presence and local productivity in both cases. Conversely, in panel studies, it is typically assumed that spillovers materialise instantaneously or with a very short time lag, which is clearly not the case. It takes time and resources before local firms are able to learn about and absorb the technologies employed by foreign firms (Teece, 1976). The main short-run effects may instead be related to competition and capacity utilisation: the new foreign entrants capture a share of the market, which means that less is available for incumbent firms which are likely to appear less productive because they are forced to reduce output with unchanged short-run capacity and capital stock.

There are also differences between studies that explore intra-industry and inter-industry spillovers. More specifically, it appears that foreign MNCs are less defensive in their relations with suppliers, subcontractors and customers than their competitors. Hence, while they may invest in protecting their competitive assets from firms operating in the same industry (Zander, 1991) they are typically engaged in knowledge-sharing arrangements with upstream and downstream partners.

Another reason is that the capability of local firms to absorb spillovers is likely to vary between host countries and industries (Girma, 2005; Kinoshita, 2001; Kokko, 1994; Kokko *et al.*, 1996). It can be assumed that spillovers are more likely when the technological capability of local firms is sufficient to understand and adopt the technologies used by foreign affiliates: in those cases, local firms can use existing knowledge to adapt and adjust foreign technologies for their own purposes. More generally, earlier studies have stressed the importance of local conditions, noting that high education levels, good infrastructure, a strong financial sector, protection of intellectual property rights (IPRs) and other indicators of relatively high development promote spillovers (Rodriguez-Clare, 1996; Javorcik, 2004; Yudaeva *et al.*, 2003). The

level of competition between foreign and local firms also matters. Incentives to learn from foreign firms will clearly be strongest when the foreign and local firms are in direct competition with each other, and when passivity will result in lost market shares and profits (Wang and Blomström, 1992; Kokko, 1996; Sjöholm, 1999).

A question that has been discussed to a lesser extent concerns the "appropriateness" of MNC technology. It has been noted that MNC technology is typically designed for the factor price ratios that apply in rich home countries, where labour is relatively scarce and human and physical capital relatively abundant. Both human and physical capital are in short supply in developing countries, which suggests that it may be uneconomical to apply foreign technologies that require large amounts of these factors: in particular, the skill requirements may be difficult to meet. Moreover, a large difference in relative factors prices – which is often an indication of a large technology gap – is likely to make it more difficult to adapt foreign technologies to local conditions. These arguments suggest that a large technology gap has a negative impact on knowledge flows, because local firms may be unable to absorb advanced foreign knowledge. An implication is that there is substantial potential for South-South knowledge flows from FDI originating in China, India and other dynamic non-OECD countries as these presumably have domestic technologies that are not too far advanced for other developing economies. However, it is possible that foreign MNCs become more concerned about leakages of technology if they only have a small technological advantage over competing local firms. A small technology gap also means that only a limited amount of new knowledge could potentially spill over.

The debate regarding the relation between the size of the technology gap and the ability of local firms to benefit from spillovers continues, and the empirical results are still contradictory. One reason is probably that foreign MNCs' technology choices and the size of the technology gap are in fact dependent on various host country characteristics which also affect the ability and willingness of local firms to invest in learning from foreign investors. For instance, it is helpful to consider the circumstances under which foreign MNCs introduce technologies that are not at all adjusted to local factor prices and production conditions. This would presumably require some form of protection from local competitors: if MNCs operate in a competitive environment, they will have strong motives to select technologies that are well suited to local conditions. With restricted competition, local firms would also have limited incentives to invest in learning, which could well explain the lack of evidence of spillovers in these environments.

A closely related reason for differences in spillovers is that the behaviour and strategies of foreign subsidiaries may vary depending on their role in the multinational corporation. It has, for instance, been suggested that export-oriented affiliates may provide less scope for pure technology spillovers than import-substituting local-market-oriented affiliates (Javorcik, 2004; Kokko *et al*., 2001). While local-market-oriented affiliates typically bring with them technologies that are weak or missing in the host country, export-oriented affiliates are more likely to focus on activities and technologies in which the host country already has a comparative advantage. In these cases, the competitive assets of the MNC may be superior marketing knowledge (related, for instance, to knowledge about foreign preferences or access to existing distribution networks) rather than superior production technology. As a result, there is perhaps no reason to expect positive spillovers of production technology to local firms (although some of the knowledge related to exporting may well spill over).

However, in these cases it is appropriate to keep in mind that the micro and macro effects of FDI may be different. Even if the technology spillovers in import-substituting industries are "larger" in some sense than spillovers in export-oriented industries, they may occur in the wrong sectors. Import substitution occurs in sectors in which the host country has comparative disadvantages and where the chances of ever developing internationally competitive firms may be weak. Even if spillovers improve local productivity in these sectors, it might be better to focus resources in other sectors. This highlights a contradiction between medium-term technical efficiency (because FDI is likely to improve productivity in protected sectors) and long-run allocative efficiency (because there are other sectors with stronger comparative advantages that should get the investments instead). A preliminary conclusion is that there is reason to be very cautious in any policy recommendations based on arguments about spillovers in sectors protected by high trade barriers.

More generally, it has been asserted that MNCs' decisions regarding the amount and kind of technology transferred to subsidiaries are important determinants of the potential for spillovers to local firms (Blomström *et al*., 1994; Sjöholm, 1999). However, the potential for technology spillovers is not only determined by the amount of technology transferred from the parent or other related firms to the affiliate, but also by the affiliate's own capability to innovate. This can be expected to vary depending on the environmental factors that motivate investments in innovative capability and on how much autonomy the parent MNC decides to grant to its affiliate.

A preliminary conclusion from these observations is that while there is potential for substantial spillovers – or knowledge flows – from MNCs to their host countries, these spillovers are not automatic consequences of FDI or the presence of foreign firms. The economic environment in the host country appears to be of great importance, determining both the kinds of technologies chosen by MNC affiliates, and how much local firms are able and willing to invest in learning from these foreign affiliates. This conclusion shifts attention to the policies implemented by host countries.

What is required for successful technology transfer?

A common conclusion from the analysis of the roles of trade and FDI for international technology flows is that countries differ in their ability to realise the potential benefits from these sources of knowledge. While some developing countries have made great progress and begun to converge towards the levels of OECD countries – with China and other East Asian economies the main success stories in recent years – others have failed to narrow the gap. It is of obvious interest to explore what may explain the differences in performance.

Cross-country differences in size and resource endowments explain some of the international variation in economic performance, but it is not likely that these are the main reasons for the differences in countries' abilities to absorb and utilise foreign technology. Instead, the reasons are probably to be found in various aspects of economic policy and institutions. The discussion on trade and FDI above has already highlighted two policy-related characteristics that promote international knowledge flows. First, studies on R&D spillovers from international trade and productivity spillovers from FDI emphasise the importance of openness and of outward orientation. For the case of trade-related R&D spillovers, it is obvious that trade restrictions will limit the range, quality and/or volume of imports that may potentially contribute to domestic knowledge. In terms of productivity spillovers from FDI, trade restrictions may either result in a fall in FDI

inflows (and a corresponding reduction in the learning potential) or a shift in the industry structure of FDI towards sectors in which foreign investors are protected from import competition. In this latter case, it is unlikely that the potential for knowledge flows is strong enough to compensate for the losses that occur when resources are allocated to sectors without comparative advantages. Moreover, foreign investors that are protected from import competition may feel that they do not have to adjust their technologies to local factor prices, since they can raise their output prices to cover costs and mark-ups. This may result in imports of technologies that are not appropriate for local conditions, and therefore more difficult for local firms to absorb. Hence, open and outward-oriented trade policies can be expected to promote technology flows for several reasons that affect both the supply of technology and the ability (and perhaps also the motives) of local firms to adopt and absorb foreign technology.

Second, and perhaps most importantly, both broad cross-country evidence and the experience of China and the other successful East Asian economies highlight the importance of systematic investments in education, science and technology, and R&D. China differs from most of today's other developing economies in its very systematic efforts to build knowledge and human capital. Chinese investments in R&D have grown at an annual rate of more than 16% since 1995 (OECD, 2008), with similar investments in higher education. In spite of the low per capita incomes, the ratio of Chinese R&D to GDP has reached 1.3%, which is higher than the ratio in EU countries such as Ireland, Italy and Spain. More than a million Chinese students have travelled abroad for higher education since the early 1980s, at the same time as several Chinese universities have developed into world class centres of research and higher education. While China is a special case, there is a direct link to the policies of other successful East Asian economies. Japan, Korea, Chinese Taipei and Singapore are all examples of economies that made early investments in human capital and managed to create a base for sustainable development.

Given their comprehensive investments in domestic technological capability and human capital, the rapidly developing East Asian economies have also been able to develop substantial capacity to absorb spillovers from foreign R&D investment, whether they are channelled through trade linkages and FDI, or diffused directly, in the form of intangible and disembodied knowledge. In fact, it can be argued that the main benefits of the knowledge investments were initially not measured in terms of the new technologies created by domestic researchers, but rather by the capacity to adapt and absorb existing foreign technology.

Of course, a host of other variables apart from liberal trade policies and investments in knowledge and skills determine the ability of developing countries to catch up to the developed world. Discussing the long-term competitiveness of developing countries in high-technology manufacturing and exports, NSB (2008) points to four areas in which substantial capacity has to be developed in order to facilitate sustainable growth and convergence. They are also important for the ability to utilise foreign knowledge. A first area is technological infrastructure, including domestic investments in R&D, education and imports of foreign knowledge. These investments make up the foundation for technical progress and competitiveness. However, although investments in technological infrastructure are necessary requirements for take-off, they are not sufficient to guarantee success. A second core area in which capacity is needed is socioeconomic infrastructure. This refers to the institutions needed to support sustainable technology-based growth and covers broader educational achievements as well as policies facilitating an open and outward-oriented policy environment. This is also the category in which important

economic institutions, such as physical and intellectual property rights, belong. The third area is productive capacity, which includes the physical and human resources available for the manufacturing sector. The final component is national orientation, and covers the policies and attitudes that constitute a business-friendly investment climate, with transparent regulation, low investment risk, and positive attitudes towards entrepreneurship and technology.

Defining and quantifying indicators for these four areas or country characteristics, NSB (2008) goes on to compare the implicit potential for developing high-technology exports in 14 developing countries. A first group consists of the large developing economies in the following order, *i.e.* from the highest to the lowest potential: China, India, Russia, Mexico, Brazil, and Indonesia. A second group includes eight smaller countries, again ranked from highest to lowest potential: Malaysia, Poland, Hungary, Thailand, South Africa, Argentina, the Philippines and Venezuela.

While it is difficult to disagree with the key areas for capacity development or the rankings of countries, it is appropriate to highlight the fact that development is related to the strength of the economic system as a whole. The countries that can be expected to be successful do not exhibit good performance only in one or two of the policy areas that are important. Instead, their overall business climate is considered favourable, with relatively low levels of risk and good prospects for future growth. Although the ranking does not explicitly recognise the importance of political stability and predictability, it is obvious that this is a crucial precondition for sustainable progress. Countries plagued by wars, political unrest or even substantial political uncertainty are likely to fail to generate the kinds of long-term investments that are needed to build sustainable capability. With reference to the rankings, it can be argued that countries such as Venezuela, the Philippines, Argentina, South Africa and perhaps even Indonesia are affected by concerns related to these issues. Moreover, it is noteworthy that an abundance of natural resources is not among the country characteristics that are considered favourable for sustainable development – several of the countries with relatively low rankings have rich endowments of resources. Although it may be difficult to argue convincingly that a resource curse is unavoidable, it is clear that abundant resources may, in a worst case scenario, mainly provide possibilities for bad policy (Sachs and Warner, 2001).

A favourable business environment is of particular importance for local enterprises, whose productivity and competitiveness are largely determined by incentives and restrictions in the domestic market, but it is also important for foreign enterprises: the local business environment is one of the main determinants of the inflows of FDI. However, few countries have relied only on a favourable business environment to attract FDI. Instead, most have introduced policies to attract FDI and to raise the likelihood that foreign technology and knowledge will spill over to local firms.

The policies aiming to attract FDI are typically based on various kinds of incentives, ranging from help with information about local business opportunities to tax holidays, employment subsidies and land grants. The main theoretical motive for providing such incentives is that FDI is eventually expected to add some value to the local economy, either directly through job creation and tax revenues, or indirectly via the technology or productivity spillovers discussed above. Where spillovers are important, the foreign investor's private benefits will be lower than the social benefits of the investment (including the spillovers). Hence, when foreign investors base their investment decisions on their private costs and benefits, they will invest less than what would be socially desirable. Total foreign investment will fall short of the socially optimal amount unless

various investment incentives encourage the foreign investor to invest more than what is motivated by a purely market transaction.

However, it is not easy to determine how much a host country should invest in investment incentives. In particular, it is difficult to predict where and how spillovers will occur. This creates problems of "picking winners". It is also difficult to calculate the value of the externalities, although this is important, since national welfare will increase only if the investment incentive is smaller than the value of the externality.

Another problem with international investment incentives is that they prepare the ground for rent seekers. It is well known from the trade literature that selectivity, in combination with lack of transparency, increases the risk of rent seeking and corruption (*e.g.* Tollison and Congleton, 1995). Policy measures that focus on broad and general forms of support that are available to all firms, irrespective of nationality, will not result in similar dead-weight losses (Kokko, 2003). Moreover, competition among governments (national or local) to attract FDI may create additional problems (Oman, 2000). When governments compete to attract FDI there is a tendency to overbid and the subsidies may very well surpass the level of spillover benefits, with welfare losses as a result. These problems may be particularly severe if the incentives discriminate against local firms.

As noted earlier, there is convincing evidence that spillovers are not automatic, but depend crucially on the responses of local firms. The potential for spillovers is not likely to be realised unless local firms have the ability and motivation to learn from foreign MNCs and to invest in new technology. This implies that investment incentives aiming to increase the potential for spillovers may be inefficient unless they are complemented with measures to improve the local learning capability and to maintain a competitive local business environment.

Taking these arguments into account, there is reason to be restrictive in the use of investment incentives that target only foreign investors. If incentives are offered, they should be available on equal terms to all investors irrespective of industry and nationality, rather than based on discretionary decisions. The motive for supporting foreign investors – including existing investors that may consider expanding their activities – is to equalise social and private returns to investment. One reason for providing at least equal support to local firms is to strengthen their capacity to absorb foreign technology and skills. Another is to avoid distorting competition between firms of different nationalities. If foreign firms have access to various investment incentives that are not available to local firms, it is obvious that local firms will not be able to compete on equal terms with foreigners actors, who already benefit from superior technical capabilities.

A further question concerns whether policy can maximise the spillovers from FDI rather than just the amount of FDI. In broad terms, the focus has been on three types of policies that affect the amount of foreign technology imported by the foreign multinationals (the "potential" for spillovers) and/or the likelihood that foreign technology will spill over. A first set of policies includes various kinds of formal technology transfer requirements that aim to force (or encourage) MNCs to bring in the types of technology needed in the host country. However, these types of requirements are rarely efficient, since it is difficult to monitor exactly how much and what types of technology the foreign MNC decides to import; most of the technology is sourced from the parent company rather than the arm's-length market, and the parent company sets the nominal price for the technology. It is also difficult to establish good incentives to ensure that the requirements are fulfilled. For instance, it is typically quite costly to follow a requirement to import any technology other than that which is motivated by profit

maximisation. If it is not very simple to determine whether a requirement has been fulfilled, it might be profitable for MNCs to do little on the technology side, and instead spend resources to convince authorities that they have actually fulfilled the requirements. Although it is possible to find cases in which strong host countries have been able to promote technology flows through regulation, the results have typically been disappointing. For instance, when looking at the operations of US manufacturing affiliates abroad, both Kokko and Blomström (1995) and Kay *et al*. (1996) fail to find any indications that technology transfer requirements would have resulted in increased technology flows to the affiliate.

An alternative to performance requirements is to design FDI incentives that are not of the *ex ante* type (*i.e.* granted prior to the investment), but rather performance-based and promoting activities that can be expected to have a particularly favourable impact on technology transfer and diffusion. These activities include education and training focused on local employees, R&D activities and linkages between foreign and local firms. An advantage of performance-based incentives is that they may affect the entire stock of investments, rather than just the flow of new investment. It is also clear that these incentives are more efficient when they are available to all firms, irrespective of the nationality of the owner. In fact, new technology and knowledge probably diffuse faster when the first user is a local rather than a foreign firm. One argument is that local firms are more likely to select technologies that are appropriate for local conditions, whereas the MNC affiliates' choice of technology is often based on what is available from the parent company. Local firms are also more deeply integrated with the local economy. They have stronger links with other local actors; this raises the number of contacts that may result in some sort of knowledge transfer. Hence, given their broad scope, it could be argued that performance-based incentives should be considered part of the economy's innovation and growth policies rather than a policy area that is only relevant for foreign investors.

Joint-venture requirements make up a second policy instrument which has been commonly used in many developing countries. One of the ideas behind these requirements is that local part-ownership in FDI projects should guarantee at least that the local partners will get access to all information about the foreign technologies and organisational practices employed in the project. However, the empirical evidence on the effects of joint-venture requirements is mixed. On the one hand, several studies find stronger spillover benefits from joint ventures (Dimelis and Louri, 2002; Javorcik, 2004). On the other, some studies fail to detect any significant differences between joint ventures and wholly owned affiliates. It appears that a larger share of the available knowledge is diffused to the local economy from joint-venture projects than from wholly owned FDI projects, but there are also differences in how much knowledge is available for diffusion in the two project types. In particular, joint ventures do not tend to receive the most recent or the most valuable technologies. To minimise leakages of strategically important knowledge and technology to outsiders, MNCs often reserve the most advanced technologies for use in the home country or in their wholly owned foreign affiliates (Blomström and Sjöholm, 1999; Muller and Schnitzer, 2006). Hence, there is a risk that the introduction of joint-venture requirements may actually reduce imports of some technologies, and perhaps even lead some investors to stay outside the local market. These risks appear particularly great for small open economies with neighbours that apply less restrictive policies, so that foreign MNCs have the option to serve the local market from alternative regional locations.

A third alternative is to encourage technology imports and technology diffusion by providing a business environment that is favourable for innovation and entrepreneurship. This involves general measures to modernise infrastructure, raise the level of education and labour skills, and provide strong IPRs, but may also include investment incentives targeting technology-intensive activities, as discussed earlier. Ensuring that barriers to competition are low may also be important to create incentives for technology upgrading and productivity growth: in fact, competition from imports and local firms appears to have a stronger impact on the technology imports of MNC affiliates than formal technology transfer requirements (Blomström *et al*., 1994; Kokko and Blomström, 1995). It can be expected that these broad measures are more efficient from a technology transfer perspective than general FDI incentives and technology transfer requirements, in particular when they are available on equal terms to foreign and local firms. One reason is that these policies will support the growth and development of local industry whatever specific effects they have on attracting FDI and promoting technology imports.

Among Western countries, Ireland seems to be an excellent example of the advantages of such policies. There is no doubt that the Irish success in attracting FDI and benefiting from such investments stems to a large extent from having the right "fundamentals" (Barry, 1999). Ireland has for a long time been considered a preferred location for FDI. It should be noted that the various incentives for attracting foreign investors, including low taxes, good infrastructure, access to the EU market, and continuously increasing labour skills, have also been available to local companies. This is a likely reason for the positive links between inward FDI and local industry found, for example, by Görg and Strobl (2001) and Barry *et al*. (2003). Another example is provided by Sweden, which was the world seventh largest recipient of foreign investment during the second half of the 1990s, and has been in the top ten in several years since then. This is remarkable for a small economy with less than 10 million consumers. Sweden provides an attractive business environment, and its industrial policies do not distinguish between foreign and domestic investors.

The relevance and relative importance of various policies will of course vary among countries, depending on market size, geographical location, level of development, and a host of other factors that determine the potential for FDI inflows and the relative bargaining power of the host country government. Large countries like China or India, with a vast domestic market, may be able to impose stronger performance requirements on foreign MNCs than small, African countries with weak infrastructure and shortages of skilled labour. Countries with a favourable geographic location – like the Baltic states – can expect stronger effects of policy reform than countries located further away from the major markets. The differences relating to the level of development are perhaps particularly interesting. There is substantial evidence that strong IPR regimes are particularly important for the ability of middle-income developing countries to attract FDI in high-technology industries (Branstetter *et al*., 2006; Lee and Mansfield, 1996; Nunnenkamp and Spatz, 2004). However, it is not likely that IPRs have equally strong effects on technology flows to low-income countries. The reason is that low-income countries typically lack many of the other resources that would be needed to attract the kinds of technologies that require strong IPR protection. Furthermore, there is a tension between strong IPRs, which aim to restrict the diffusion of knowledge, and the typical objectives of low-income countries, which emphasise speeding up modernisation and technology diffusion, and in which the number of firms or entrepreneurs who own domestic intellectual property is very small. Hence, while IPRs are likely to be of crucial importance for emerging markets that aim to upgrade from assembly operations and other

low value-added activities to more sophisticated industry, they might not be equally urgent in the poorest countries, where more general property rights, infrastructure and general education have higher positions on the list of investment priorities.

Conclusion

The global production of knowledge and technology is highly concentrated in just a few developed nations – Japan, the United States and the largest EU countries – and in a relatively small number of multinational corporations headquartered in these nations. The top 25 technology-producing MNCs spend more on R&D than the entire non-OECD world. It is therefore not surprising that most countries are dependent on foreign knowledge and technology for growth and development.

There are many different channels for international technology diffusion, ranging from trade and FDI to tourism and international student exchange. This chapter has focused on the role of trade and FDI in international knowledge flows and discussed empirical findings as well as policy conclusions for countries aiming to facilitate the inflows of technology through these channels. Abstracting from the vast diversity of the developing world, which means that specific policy recommendations need to be tailored to the economic conditions in each country, it appears that some conclusions apply more or less across the board.

From the findings of empirical studies, it seems clear that both exports and imports are important from the perspective of technology diffusion. Imports – especially imports of investment goods and services – contribute directly to technology upgrading. The evidence on learning from exporting is somewhat less consistent, but there is no doubt that firms in outward-oriented economies establish stronger contacts with the international market than actors in inward-looking markets. These contacts – whether with customers, suppliers or other business partners – are of high importance for knowledge flows. Foreign direct investment is important, because it results in international technology transfers – affiliates of foreign MNCs typically introduce technologies that are not commonplace in the host economy – and because there is a potential for spillovers of knowledge to local firms. However, spillovers of technology are not automatic consequences of foreign presence, but rather conditional on the capacity and motives of local firms to understand, absorb and adapt foreign technologies to local conditions.

This suggests that outward-oriented trade policies and policies promoting education, training and R&D are important components of any policy package aiming to maximise knowledge flows to developing countries. In addition, there is reason to emphasise the importance of a favourable business environment that provides strong incentives for entrepreneurship, investment and innovation. Infrastructure, strong property rights and other economic institutions, investments in human capital, and in some cases perhaps also incentives for knowledge creation, are assets that promote both the technology imports of foreign MNC affiliates, the ability of local firms to absorb potential spillovers from FDI, and the independent innovation and entrepreneurship of local firms.

In some instances, it is also possible to argue that specific FDI incentives are warranted, to assure that the amount of FDI does not fall short of what would be socially optimal. However, it is difficult to determine what the optimal amount of FDI incentives is, and it is inappropriate to provide incentives to foreign investors if similar incentives are not available to local firms. The reason is that discrimination against local firms will

make it very difficult for local industry to compete efficiently with foreign-owned firms. This is likely to reduce the ability of local industry to absorb the potential spillovers from FDI – in particular, the scope for horizontal spillovers (directed to the industry in which the foreign investors operates) will diminish if preferential treatment of foreign firms puts local industry at a disadvantage. Therefore, to the extent that specific incentive programmes are used, they should probably be designed to target specific behaviour (*e.g.* investment in local human capital) rather than investment in general, and they should be available on equal terms to local firms. For the vast majority of all economies, it is the business environment for local industry that determines long-run development. It is not likely that any preferences or incentives offered to foreign investors can compensate for weaknesses in domestic industry and entrepreneurship.

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Chapter 7

Innovation Strategies in Developing Countries

by

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This chapter explores issues relating to innovation strategies in developing countries. By flagging some key issues in the literature, it identifies the many dimensions of innovation strategies in developing countries and examines the implications for different developing regions. It suggests that innovation strategies that are shaped by domestic market and policy realities are more robust and help to improve the performance of enterprises at country level. As countries differ in their challenges, resources and needs, their policy and development frameworks necessarily vary considerably. This chapter draws some tentative conclusions from the literature, which suggests that strategies based on innovation systems are, to some extent, replicable.

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Introduction

The world's collective accumulation of scientific knowledge, technological capabilities and competences for innovation has advanced the well-being of billions of people across 192 sovereign political entities (United Nations, 2006). This progress is however not evenly distributed nor has it been achieved without anthropogenic impacts on the planetary ecosystem. Inequality, insecurity, environmental degradation and an uneven spread of infrastructure and technical know-how conspire to produce an asymmetry between the concentration of knowledge and the demands of equitable development. The planet's 6.8 billion people[1] are further challenged by concerns over the increasing gap in the quality of life between and within all countries, the rapidity of global climate change, the extensive international financial crisis and the subsequent more generalised economic recession.

The changes of the past century are largely attributable to a particular form of economic development. This period of accelerated change has mainly been characterised as the growth of productive capacities through industrialisation, mass production and distribution. The current era is a time of increased international integration, and globalisation today embraces not only the financial sector, but also investment, production and distribution systems (Maharajh, 2008). The mobility of highly skilled people has also increased (Pogue, 2007; see also Kahn *et al.,* 2004). Within capitalist systems, the key tools for facilitating economic expansion have been the mobilisation and organisation of society's capacity to generate new goods and services from accumulated traditional knowledge, endogenous research and development (R&D) strategies, and international science and technology (S&T) co-operation. This has been achieved through a process of generating the necessary capacity, largely by S&T institutions. As these enterprises have grown in scale and complexity, they have transcended geo-political and sectoral boundaries. The literature on systems of innovation (Fagerberg, 2005) has kept pace with these developments through an expanding network of scholars, policy makers and administrators.[2]

Knowledge contributes to innovation insofar as the latter is the successful application of the former. The process whereby knowledge is generated and acquired through to its transformation into a useful form and its implementation is non-linear and dynamic. The traditional relationship between knowledge suppliers and users has changed and has blurred the boundaries between the public and private sectors with respect to innovation. In addition, the interconnectedness of different policy domains, the search for contextually determined local relevance and the enormity of present global challenges have made the development of an innovation strategy increasingly complex. Furthermore, it is important to recognise that policies and politics are co-dependent and that public policy choices represent power relations in the society, the country and globally.

This chapter is concerned with the ways in which knowledge contributes to innovation.[3] It views the relationship as dynamic and complex. It provides a starting point for assessing how innovation policies can potentially generate more effective strategic responses in developing countries. It does so by looking at some of the key issues that have arisen in the literature concerning the developing regions of Africa, Asia and Latin America.

Government policies that seek to increase the rate of innovation have become more widespread and have benefited from feedback from learning through implementation. The role of innovation policy in generating initiatives to promote the better country-level

performance of enterprises is increasing. The rapid expansion of policies and associated instruments is even affecting large sections of least developed countries (LDCs).[4] Continuities in the development discourse remain, however, as developing regions still benchmark their policy and strategy choices on policy research in more advanced and mature economies. At the same time, and almost simultaneously with the evolution of thinking about policy management and priorities in the more industrialised economies, innovation strategies in developing countries have begun to move beyond supply-side strategies towards more demand-led options. Countries with more advanced and mature economies are engaging in debates on the relevance of "national" innovation strategies in the context of their relations with each other and with developing regions. Although this issue is not addressed in this chapter, it increases in significance in light of the dynamics of a truly globalised world facing the prospects of crises. It indicates the need to acknowledge that innovation policies should be informed and guided by the historical, socioeconomic and political context of individual countries and the global challenges of sustainable development.

Emerging from contemporary studies on innovation systems is the notion that innovation in developing countries needs to be understood broadly. Given the persistence of economic dualisms in most developing countries,[5] innovation should cover innovation in the informal sector and in traditional sectors (such as agriculture, energy and mining). Also, since the level of innovation in most LDCs is generally below the global technology frontier, considerations regarding innovation policies should be closely aligned with existing processes of technological learning.

Finally, given the particular constraints and challenges that characterise the various actors in developing economies, innovation needs to be considered as a systemic process, strongly linked to specific domestic conditions. This chapter aims to provide directions for the design of contextualised innovation policies that also take account of current trends in global integration.

The recent history of innovation strategies in developing countries

Early innovation theories developed in more advanced industrialised economies emphasised the role of technological progress and radical innovations (Schumpeter, 1947; Kline and Rosenberg, 1986; Freeman, 1987; Freeman and Soete, 1997). This perception of innovation led to a stream of policy recommendations aimed at the promotion of S&T outputs – R&D, technical manpower, patents and scientific publications (see Chapter 3 in this volume). As a consequence, government initiatives in developed and developing countries have mainly focused on supporting formal R&D and on improving the mechanisms for transferring the results of public and foreign R&D to the domestic private sector.

However, theoretical advances in evolutionary economics suggest that innovation is not linear but takes place in an "innovation system" that is the result of complex and multiple interactions at the national, regional, local and even sectoral level among a variety of actors and their environment (*e.g.* Freeman, 1987; Lundvall, 1988, 1992; Nelson, 1993). These developments in the literature follow the earlier more industrially oriented conceptualisation of Richard Nelson (1982). Over time, our understanding of innovation has been enhanced through incorporation of the experience of developing countries and through the increased availability of data that highlight the effects of networking, learning and collaboration by the many actors of the innovation system.

The economic success of some East Asian countries in the 1980s and 1990s triggered interest in understanding the nexus of technological performance and innovation policy in developing regions. Development theorists started studying the fast-growing newly industrialised economies (NIEs) and the role of government in promoting their dynamism (*e.g.* Pack and Westphal, 1986; Amsden, 1989; Wade, 1990; Lall, 1992; Hobday, 1995; Kim and Nelson, 2000). Strong technological content (and the role of technological learning and imitation) led to an emphasis on policies for technology transfer, assimilation and acquisition of foreign technologies. At the same time, research attention also focused on the role of indigenous efforts to assimilate foreign knowledge and technologies as well as to acquire domestic innovative capabilities.

In Latin America initial views of innovation strategies were influenced by a general debate about industrial policy and were strongly marked by structural adjustment programmes and subsequent economic reforms (*e.g.* Katz, 1984, 1987; Teitel, 1984). However, with the emergence of new patterns of production, specialisation and trade, innovation strategies paid particular attention to the diffusion of innovation and knowledge, local industrial clusters and the benefits of collaboration.[6] Details on the linkages between innovation and local production systems have been collected by the Research Network on Local Productive and Innovative Systems (RedeSist)[7] in Brazil.

In Sub-Saharan Africa, early debates on innovation strategies were influenced by the tensions between the revisionist approach, which favoured policies of state intervention (Stein, 1992; Griffin, 1996; Lall and Wangwe, 1998; Mkandawire and Soludo, 1999), and the neoliberal agenda, which advocated minimising the role of government while focusing on "getting the fundamentals right" (World Bank, 1994, 2000).[8] In spite of the significant advances in certain African countries in the last three decades (such as South Africa, Mauritius and Mozambique) and at pan-African level,[9] entities, organisations and institutions that explicitly seek to enable innovation are still developing. The challenges of implementation, monitoring, evaluation and learning still constitute major hurdles for Africa's various innovation policies, strategies and programmes. The African Science, Technology and Innovation Indicators (ASTII) project of the NEPAD will help the continent as a whole as more countries begin to use OECD methodologies to collect information.

It is more or less generally agreed that innovation and technology are strategic variables in any development process. Researchers and policy makers differ about which aspects and stages of innovation can and should be promoted, as well as about how "success" can and should be measured in developing regions. Some maintain that international market mechanisms appropriately assign innovation resources to the actors best able to exploit them productively. A second school of thought is critical of the dependence of developing countries on foreign technologies and seeks an enhanced role for indigenous innovative capabilities. A third position maintains that what is important for developing countries is the achievement of the right combination of imported technologies and locally developed innovative capabilities. From this last perspective, the focus on acquiring technologies abroad would not be incompatible with the aim of promoting indigenous innovations. This tends to increase the complexity of the technology transfer process.

As a result of the multiplicity of views on this issue, the current debate on innovation strategies in developing regions remains polemical and controversial. It reflects the past history of differences in the understanding of innovation processes in both developed and developing countries, as well as the recognition that policies that rely solely on technology

transfer, narrowly framed, have failed. Different views on innovation and effective technology transfer ultimately affect the allocation and use of scarce resources in developing countries, as well as the development of the institutional system that supports innovative activities. Fortunately, the utilisation of common measurement devices is improving the availability of comparable data. The fact that most regions of the world are beginning to utilise the OECD's *Frascati Manual* (2002) and the OECD/Eurostat *Oslo Manual* (2005) augurs well for basing debate on evidence and moving beyond mere rhetorical posturing by stakeholders, role players and policy makers.

Is innovation different in developing countries?

One of the most fundamental global trends over the last decades has been the accelerating rate of innovation and change. Developing countries increasingly participate in this evolution, as changes wrought by rapid innovation at the global level have led to new opportunities for developing regions. This has especially been the case when domestic policy has sought to increase capacity to absorb global technological advances through appropriate support for capability formation functions.

Technological change has profoundly affected the dynamics of global production chains, with important implications for both the rapidly emerging developing countries and the LDCs. While the rapid pace of innovation has raised entry barriers in certain activities and industries (such as pharmaceuticals and biotechnology), global outsourcing has provided increasing opportunities for lower-cost sites in developing countries in sectors such as information and communications technologies (ICTs) (Kraemer-Mbula, 2009a). Companies in developing countries now compete not only with suppliers in higher-cost locations in advanced economies, but also among themselves. The ability to innovate and respond to fast-changing and newly arising opportunities has become a deciding factor in the success and survival of firms in developing regions as well as in advanced economies.

Yet, in spite of the falling costs of communication and the growing integration of economic activities around the globe, enterprises in developing countries still remain relatively isolated from global innovation dynamics. This is in marked contrast to the experience of enterprises located in more advanced economies. Hobday (1995, 2003) highlighted the physical and "virtual" distance of latecomer firms from major international sources of technology, R&D, universities and mainstream international markets. This disadvantage already places latecomer firms at a different starting point in terms of innovation processes from that of firms in more advanced economies.

This partially explains the significant differences in innovation activities, performance and results within and between countries. The burgeoning literature on latecomer enterprises has taken into account the different economic, social and technological environment in which firms in developing countries operate. Some of these particularities are related to the pervasive technological isolation of firms, the existence of market failures, differences in types of innovation (*e.g.* incremental innovations, learning), the greater presence of traditional sectors of production, the scale of the informal sector, and the tacit knowledge base of technologies.

Although scholars recognise the diversity of the developing world, they also identify common market failures that can significantly limit the success of innovative efforts. Weak financial and labour markets, dysfunctional education and training systems, inadequate intellectual property rights (IPR) regimes and regulatory systems, and poor

support for investment in innovation characterise many developing countries across the globe. Efficient markets allow latecomer firms not only to obtain the necessary resources to innovate, but also to appropriate the returns from their innovative activities. This constitutes an incentive to invest in further innovations. However, it has been argued that the ability of firms to access finance, human resources and other technical inputs cannot always be ensured by market mechanisms (Lall and Teubal, 1998; Lall and Pietrobelli, 2002). Correcting such limitations often requires direct interventions.

These limitations, which are not unique to developing countries, may also affect the ability of innovative firms to market their goods and services and to continuously improve their technical capabilities in order to face competition. Particularly in least developed countries, problems of appropriability of innovations, failures in financial markets and poor technology infrastructure, among others, have suggested that "strict reliance on a market system will result in underinvestment in innovation relative to the socially desirable level" (Martin and Scott, 2000, p. 438; also supported by authors such as Lall and Teubal, 1998; Romijn, 2001). Given these constraints, many have indicated the need for tailored and strongly supported innovation strategies to address the pervasive market and institutional weaknesses in developing countries, especially LDCs.

Innovation in developing countries is affected by the ability of firms to solve problems and overcome existing structural, infrastructural, institutional and financial constraints. Recent research from Srinivas and Sutz (2008) highlights the importance of considering the context in which technological innovation takes place, since conditions of scarcity – as opposed to abundance – are often the source of innovations in developing countries. This is particularly the case in emerging technology-intensive activities that rely on modern infrastructure, such as ICTs, which tends to be scarce in developing countries (Kraemer-Mbula, 2009a). Additionally, as most generic technologies are imported or generated abroad, innovation in developing countries is likely to be based on adopting, adapting, imitating and improving foreign technologies. Examples of successful innovators in developing countries indicate that incremental innovations, rather than radical innovations, are the main source of their innovative performance (this is supported by the findings of many innovation surveys, such as those of South Africa[10]).

As currently understood, innovation is something that occurs in firms as formal organisations. Ironically, even the more comprehensive concept of national systems of innovation has yet to fully incorporate and address innovation that takes place in the informal sector (see Chapter 4 for further discussion of the informal sector, particularly in Africa). The informal sector, especially in developing countries, comprises millions of enterprises that operate under extreme conditions of survival, scarcity and constraints. The dynamics of innovation in the informal sector, which is most extensive in developing countries, are largely ignored in the literature on both developing and more developed economies. Yet disregarding the role of such innovation in developing countries produces misleading, asymmetrical or ineffective innovation strategies.

Frequent issues in the literature on innovation strategies in developing countries

Drawing on the issues most frequently addressed in the literature, this section detects five important dimensions: generation of innovation, assimilation of innovation, diffusion of innovation, the enabling environment and policy management. Not all of these dimensions need to have equal emphasis in all countries, as an adequate innovation strategy will depend on the particular needs of an economy. The rise of evidence-based policy formulation can help to reveal the specific needs of individual economies.

Generation of innovation

Historically, the generation of innovation has been measured using input and output indicators. Inputs have mainly been identified with R&D expenditures, both public and private (government, business and higher education expenditures on R&D). Output measures have included counting patents and scientific publications (OECD, 2002, 2007; UNIDO, 2002, 2004, 2005). However, the situation has now moved well beyond the simplifications of input-output tables.

One well-known criticism of the heavy reliance on these indicators for policy making is the observed tendency to identify innovation strategies with R&D strategies, on the basis of "research in, technology out" (UN, 2003; Bell, 2006). This view implicitly considers innovation outputs and other technological advances the result of a linear process driven by the supply of R&D resources and other inputs (such as technical personnel). Innovation strategies designed on this basis assume that promoting the supply of inputs will result mechanically in a higher level of innovative capabilities (UNU-INTECH, 2004).

In contrast, the now widely accepted innovation systems framework describes innovation as the result of complex interactions among actors, both national and international. This branch of the literature caricatures firms in developing countries as technologically immature (Kim and Nelson, 2000). As argued by Gabriela Dutrénit (2004, p. 210) "[firms in LDCs] do not engage in radical innovation but tend to learn over time, they accumulate knowledge, and, on these bases, they are able to progressively carry out new activities and innovate". The gradual, incremental and interactive generation of innovations based on learning – which in LDCs often develops as response to lack of, weak or inadequate inputs (Srinivas and Sutz, 2008) – evidently calls for different measures. Output indicators are clearly insufficient for describing the complex, multidimensional aspects of innovation processes that depend not only on formal investments in R&D but also on gradual knowledge sharing and interactivity with other actors of the innovation system (UN, 2003).

The generation of innovation in developing countries therefore has a somewhat different starting point from that of more advanced economies. Particularly in LDCs, it also takes place largely outside of formal firms and institutions, in the informal economy, which constituted the livelihood of an average of half to three-quarters of the active urban population in 44 LDCs from 1990 to 2004 (UNDP, 2007). Moreover, current trends in urbanisation, unemployment and population growth suggest that the informal economy in LDCs will grow (see Chapter 4 for further discussion). Admittedly, the upgrading of technologies in small-scale informal urban businesses in LDCs has not received the attention it deserves. Yet even formal firms (especially small and medium-sized enterprises) often spend on informal innovation activities (Bougrain and Haudeville, 2002). By adopting and adapting technologies, firms, as technology users, are able to develop a range of skills and resources. These are usually hard to estimate but can be very relevant, especially in developing countries. Unfortunately, a large part of these activities may not be captured in R&D or innovation surveys (Gault and von Hippel, 2009). As a result, the impact of these informal activities is usually absent from policy deliberations.

Acquisition and assimilation of foreign innovations

Developing countries have traditionally depended on technologies generated abroad. Therefore, their ability to acquire and assimilate innovations generated abroad has been regarded as critical. Yet, mere acquisition of foreign technologies is not sufficient. Once

innovations have been acquired (or technology imported), local efforts are essential for mastering its tacit elements (Lall, 2000, p. 7), adapting them to local conditions and improving them over time. This complements the notion of user-initiated innovation (Gault and von Hippel, 2009).

The successful acquisition of foreign innovations has very much to do with the outward orientation of a firm, sector or country and with participation in global production networks (Ernst and Kim, 2002). Therefore, innovation strategies that pursue the acquisition of technological knowledge have traditionally focused on reinforcing the reliance on foreign investment, joint ventures and imports of capital goods. The usual perspective on technology spillovers from foreign direct investment (FDI) sees the subsidiary of the multinational company (MNC) as a passive actor. However, recent research suggests that technology and knowledge spillovers are more effective when domestic companies incorporate domestic innovation (Marin and Bell, 2003; Marin and Sasidharan, 2007). From this perspective, external sources of innovation and technology are not a substitute for strengthening domestic innovative capabilities but rather as a significant complement.

While acquiring technology might be a matter of access to foreign markets and finance, effective assimilation of technology generally requires a broad base of skills and a critical mass of technical expertise. This focus on human resources as pivotal for the assimilation of foreign innovations has driven innovation strategies in developing countries, with the establishment of centres of excellence to enhance their scientific capacity and initiatives to promote technical training. However, assimilation requires more than the existence of sufficient technical skills. It demands deliberate and explicit investments and efforts by domestic firms, such as on-the-job learning and knowledge sharing (Bell, 2007). Developing and improving the set of absorptive competences in developing country firms is crucial but widely ignored in research studies and surveys.

An important advance is best articulated by Lundvall and Borrás (1997) who stressed the concept of the "learning economy", arguing that what really matters for economic development is the ability to learn rather than the existing stock of knowledge (Lundvall and Borrás, 1997, p. 35). They highlight the link between learning and change[11] as the source of economic dynamism, regardless of the initial technological endowments. They recognise that globalisation of technology offers new opportunities for developing countries, but argue that these opportunities are not available without deliberate efforts to absorb innovation through endogenous learning. In summary, global competition generates the need for developing countries to ensure that their domestic innovation strategies respond intelligently to this learning effect and its implications for the formation of capabilities that are in demand.

Diffusion of innovation

Diffusion is the process by which an innovation is communicated through certain channels over time among the members of a social system (Rogers, 1995). The diffusion of innovation is not automatic. It requires a significant level of absorptive capacity and the ability to assimilate or internalise the disseminated knowledge, which, as mentioned above, does not occur without cost or effort.

The literature on the diffusion of innovation is ample, and diffusion has been identified as a crucial ingredient of innovation strategies in developing countries. However, current understanding of the local capabilities necessary for the effective diffusion of innovation in a particular context is very limited.

The international diffusion of innovation through formal mechanisms such as foreign direct investment and foreign licensing has been extensively studied (see Chapter 4 for further discussion of FDI in innovation studies). However, it has also been recognised that a large amount of technological knowledge is transferred through various informal mechanisms (Ernst and Kim, 2000; Figueiredo, 2001). Despite the recognition of the importance of informal interaction and tacit knowledge flows within and across organisations (*e.g.* Breschi and Lissoni, 2001; Jensen *et al.*, 2007), empirical research on these aspects remains scarce. The composition of local capabilities to assimilate, adapt and improve foreign technology requires further consideration, not simply in order to maximise the benefits from knowledge transfer but also to effectively engage in joint learning and knowledge sharing with foreign providers of technology.

The growing literature on clusters and experience with industrial clustering in developing countries have made useful contributions concerning networking and collaboration among actors (local and foreign) (Bell and Albu, 1999; Mytelka and Farinelli, 2000; Giuliani *et al.*, 2005; Pietrobelli and Rabellotti, 2007). In the main, these studies suggest that networks have acted as a catalyst for international knowledge diffusion and provided new opportunities for local capability formation in lower-cost locations. Recent research illustrates the transition of some of these clusters from competition based on low costs to innovation-based competition (Chaminade and Vang, 2008).

Enabling environment

For many developing countries the fundamental problem is simply the lack of an explicit innovation strategy. Nevertheless, the mere existence of an innovation strategy does not ensure that firms' technological and non-technological efforts are translated into increased rates of innovation, and subsequently into greater competitiveness and better economic performance. For countries in which innovation strategies exist, the efficiency with which they are implemented also matters. Structural problems, including corruption, institutional barriers and overall anti-competitive behaviour, also help to hinder the successful implementation of innovation strategies in developing countries and LDCs.

Increased opportunities for domestically inspired policy choices have only now begun to emerge, as more countries free themselves of massive debt obligations. With improved macroeconomic conditions, there is room for policy efforts and interventions at the microeconomic level. The current financial contagion has generally dampened international demand and government interventions to rescue failing enterprises may undo the positive gains achieved in recent times. Government indebtedness is increasing in the more advanced countries, together with unemployment and a reduction in the availability of finance. The effects on developing countries are still emerging in a context of global forecasts of deep depressions following the current recession (World Bank, 2008).

The period following structural adjustment (after 1999) appears to have improved conditions for experimenting with incentives and regulations that can spur innovation. There are opportunities for framing innovation policies in developing countries in line with more comprehensive development strategies. To increase the probability of success, innovation strategies must take into account and promote broader socioeconomic goals and inform policy at the micro, meso and macro levels.

Co-ordination of innovation policies

The implementation of an innovation policy requires the capacity and capabilities to steer a coherent innovation strategy through the co-ordination of complex systems. The difficulty of managing and administering the strategy is often compounded by the short-term horizons of electoral cycles. To ensure a successful innovation strategy, governments in developing countries need to establish a clear vision of the improvements sought, ensure a transparent regulatory and incentive structure, and define possible technological trajectories in line with the objectives of their innovation policy. The vision should be founded on the dynamics observed in the private and public sectors and on their consistency with goals of global integration.

The role of developing country governments in shaping innovation strategies in order to address technological trajectories, lock-ins and social demands for near-term amelioration is crucial. However, little has been done to analyse processes of policy making in developing countries and to identify the ways in which policy makers in these regions can better define priorities and avenues for implementation.

Many scholars have acknowledged that an effective innovation strategy requires co-ordination of multiple layers of support policies (Lall and Teubal, 1998; Lundvall and Borrás, 1997; Rodrik, 2007; Freitas and von Tunzelmann, 2008). In developing countries, these layers of intervention need to be adjusted and co-ordinated so as to effectively promote innovation as well as other core development goals such as alleviation of poverty. Max Rolfstam has recently drawn particular attention to the critical role played by public procurement of innovation (2008).

A major contribution by Lall and Teubal (1998) pioneered concerns about these issues in the literature. Reviewing the role that technology policies played in East Asian economic growth, they identified three types of policies: *i)* functional interventions, intended to improve markets operations without favouring particular activities; *ii)* horizontal policies, designed to promote specific activities across sectors, such as incentives to promote greater innovation, R&D and training; and *iii)* vertical policies, designed to promote the advance of particular sectors.[12]

Other authors have adopted variations of this three-dimensional taxonomy. For instance, Lundvall and Borrás (1997) described the three elements of a broadly oriented innovation policy as: *i)* policies affecting the pressure for change (competition policy, trade policy and the stance of general economic policy); *ii)* policies affecting the ability to innovate and absorb change (human resource development and innovation policy); and *iii)* policies designed to take care of losers in the game of change (social and regional policies with redistribution objectives).

This three-dimensional framework provides a format for designing government support of innovation and for defining priorities and levels of intervention for the effective promotion of innovative activities. However, its specific use is largely defined by the context in which it is applied, since the authors recognise that "the exact mix var[ies] with country context and the capabilities of its policy makers" (Lall and Teubal, 1998, p. 1370).

Policy implications for developing countries

The comparison of innovation strategies and their replication across countries has been a matter of heated debate. Success and performance have largely been assessed through international benchmarking exercises. For instance, Archibugi and Coco (2005) argue that international comparisons are meaningful, regardless of differences in social, cultural and geographical contexts. They aggregate various statistics on technological capabilities, assuming that individual indicators are complementary rather than substitutes.

Others have argued that success and performance need to be evaluated at the local level and put greater emphasis on the need for policy experimentation in developing countries (*e.g.* Lundvall *et al.,* 2006; Sutz and Arocena, 2006; Srinivas and Sutz, 2008; Juma and Yee-Cheong, 2005). They highlight the need to open up new development trajectories with greater emphasis on generating knowledge and learning, and they argue that a global basis for measuring and assessing innovation strategies, incentives and regulations does not reflect the innovative activities that are in fact taking place in developing regions.

This chapter stresses the importance of evidence-based policy experimentation. However, it is also essential for policy makers to learn from the experiences of others in order to design and implement an effective domestic innovation strategy (Kraemer-Mbula, 2009b, p. 11). Key policy dimensions therefore need to be identified and benchmarked internationally to draw useful lessons from the experience of other developing regions. This latter point is particularly relevant, considering the urgent need to accelerate innovation and socioeconomic development in developing countries. Although international comparisons are useful, generic one-size-fits-all solutions are bound to fail. It should be noted that the price of policy and strategy failures usually means significant costs for developing countries and especially for LDCs.

Role of donor countries in facilitating the implementation of innovation strategies

The international implications of domestic policy take on greater importance in the context of an increasingly globalised economy. While they seek harmonisation, multilateral institutions such as the World Trade Organization, the World Intellectual Property Organization, the World Bank and the International Monetary Fund continue to exert a strong influence over local policy on research activities. Indeed, many of their interventions do not seem consistent with the overall institutional frameworks of developing countries. Although the diffusion of "innovation" thinking is generally beneficial, the application of a single form of innovation strategy to various local conditions requires caution.

The World Summit on Sustainable Development, multilateral environmental agreements and climate change offer a set of global challenges which require multilateral international efforts. At the regional (supra-national) level, various voluntary associations such as the New Partnership for Africa's Development (NEPAD) have encouraged many countries to increase their participation in science, technology and innovation. Because their efforts offer broader-based access to organisations beyond state actors, they make available a wide variety of opportunities. Countries need more support for conducting studies based on internationally comparable methodologies and for encouraging regional co-operation on sharing of experience and policy learning.

This situation requires innovative approaches with respect to donor co-ordination, mobilisation of resources and alignment with the domestic development agenda. The value of an innovation systems approach is maximised by achieving coherence between different actors and competing agendas.

Conclusion

Knowledge is increasingly recognised as a critical determinant of economic growth, good governance and improvements in the quality of life, in spite of disagreements within the development paradigm and economics more generally. Nonetheless, development thinking based on evolutionary economics and innovation systems confirms that knowledge is transformed into goods and services through a country's enterprises, higher education institutions and public research institutes. It is in fact these entities' relationships with the policy environment that largely shapes a national system of innovation.

The literature confirms that skilled people are the most effective means of knowledge transfer and adaptation. The central role of human capacity, capability and competence formation for innovation should not be underemphasised. Coherent and effective administration and suitable governance regimes are necessary to ensure the co-ordination of complex systems. However, there is the risk that the areas of greatest need in this respect may not attract a sufficient supply of human resources. The problem may also exist in more advanced economies, but it is especially present in developing countries. In times of significant economic and financial flux, safeguarding policy gains that offer much more in the long run than in the immediate future is also important.

With this in mind, it is tentatively suggested that innovation policies and strategies should undertake the following efforts:

- *Build domestic STI policy competences through evidence-based research*. It is crucial to build intermediary facilities that institutionalise and build the overall capacity for policy research and learning. Most fast-emerging developing countries are investing in these capabilities in government and in the public higher education sector. These initiatives require co-operation and support to ensure that domestic situations gain advantages from global networks and more mature institutions in the North.
- *Improve policies and institutions within a framework of autonomy and accountability while ensuring that learning from implementation is acknowledged and progressively feeds back into improving strategies*. To ensure that policies remain relevant, flexible and agile requires building monitoring, evaluating and learning into strategic frameworks. These strategic frameworks will benefit from clearly defined and articulated goal-setting processes involving wide participation of enterprises, universities, public research institutes and civil society organisations. Democratically defined terms of autonomy would improve the competences of performing and funding agencies. Not only would this ensure accountability, it would address concerns about trust, co-operation and competition in small economies.
- *Recognise and support human resource development and management capability formation*. It is important to maintain the broad goal of maximising human resource development, but specific attention should be paid to the need to expand the cadre of management practitioners who can contribute significantly to improving

the coherence and alignment of policy and strategies. This need is especially great in project and programme management. The complexity of developing country contexts and the non-linearity of STI policies and strategies also increase the demand for skilled managerial professionals. Ensuring that STI policy managers have access to continuous upgrading of their learning is another challenge. Increasing the stock of capable and competent STI managers is therefore essential to ensure appropriate implementation, monitoring, evaluation and improved system-level performance.

- *Achieve funding sustainability through public-private interaction and cost recovery*. The scarcity of finances in the face of competing demands on the public purse necessitates the exploration of innovative funding regimes. Much has been learned from domains such as infrastructure development for exploring means of recovering the costs of public support and of encouraging greater co-operation between public and private enterprises.

- *Aim at merit and scientific rigour through competitive funding, peer review, etc.* Utilising a principle embedded in the very definition of scientific research and knowledge for broader application in selecting projects and programmes would improve quality and encourage wider experimentation. This would also improve the validity and veracity of the evidence base for policy and strategy reform and could lead to improvements in institutions and agencies as they seek to ensure greater alignment and coherence with local realities and policies.

- *Enhance existing linkages and establish new ones between the productive and the knowledge sectors, while ensuring improved access to basic research and the growing international knowledge base*. It is essential s to improve the relationship between users and producers of knowledge. The literature shows the growing recognition of the importance of user perspectives (*e.g.* von Hippel, 2005). The spread of increasingly open and global research practices poses significant challenges for improving the endogenous innovative capacities of developing countries. Much can be gained from seeking alignment of international support and local needs. Carefully constructing international research collaboration in a manner that helps to address local constraints offers possibilities for equitable development.

Notes

1. United Nations, Department of Economic and Social Affairs, Population Division, *www.un.org/esa/population/unpop.htm*.
2. Globelics, the global network for learning, innovation and competence-building systems is one such initiative, *www.globelics.net.*
3. Following OECD/Eurostat (2005), innovation is defined as the realisation of the value created through the introduction of a new product (a good or a service) to the market, the introduction of a new process that produces products for the market, or delivers them, the use of new organisational structures or business practices, or the development of new markets or the capturing of a greater share of existing markets.
4. The subtitle of UNCTAD's 2007 Least Developed Countries Report was "Knowledge, Technological Learning and Innovation for Development".
5. See the eloquent statement of former South African President Thabo Mbeki on the "two nations' divide" (Mbeki, 2003) and the more empirical UNDP/HSRC/DBSA (2005).
6. Reviews of relevant empirical cluster studies in Latin America can be found in Albaladejo (2001) and Pietrobelli and Rabellotti (2007).
7. *www.redesist.ie.ufrj.br/Ev/home.php*.
8. This later became "getting the institutions right" (as noted by Rodrik, 2006).
9. For instance, the establishment of the African Ministerial Council on Science and Technology (AMCOST) in 2003 under the auspices of the New Partnership for Africa's Development (NEPAD) and the African Union (AU). AMCOST is a high-level platform for developing policies and setting science, technology and innovation priorities for African development; see *www.nepadst.org*. Also, the Consolidated Plan of Action of NEPAD, which was endorsed by the AU Summit in January 2007, proposes specific regional programmes to promote the role of science and technology to support social and economic development in Africa – the full document can be accessed at *www.nepadst.org*.
10. Available on the Human Sciences Research Council (HSRC) website, *www.hsrc.ac.za*.
11. "Rapid change implies a need for rapid learning, and those involved in rapid learning impose change on the environment and on other people." (Lundvall and Borrás, 1997, p. 36)
12. The impact of each of these layers of intervention has been tested for the ICT sector in South Africa by Kraemer-Mbula (2009a).

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