OECD Reviews of Regional Innovation

Globalisation and Regional Economies

CAN OECD REGIONS COMPETE IN GLOBAL INDUSTRIES?

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Foreword

The competitiveness of a regional economy depends in part on demand for its exports and on its ability to produce those goods and services at competitive prices. The location of economic activity in OECD countries has been strongly influenced by the ability of firms to draw increasing returns by expanding production in particular places. The spatial pattern of economic activity is not static, however. The coincidence of an apparent acceleration of globalisation over the past decade with significant employment losses in manufacturing in many regions has raised concern that the comparative advantages of OECD regions in different industries, often built up over decades, are no longer robust foundations for their economies. A frequently cited survey of the views of citizens in the EU on globalisation found that when asked what comes to mind when hearing the word globalisation the most common response was "delocalisation of companies to countries where labour is cheaper" (Eurobarometer, 2005).

Concern over the future of manufacturing in the OECD is partly explained by a perception that what OECD regions can offer in terms of skills, business environment, etc., has ultimately become less valuable to global firms than what they can get in lower wage economies where competencies are increasing rapidly. Yet, evidence of continuing geographic concentration of industries in OECD regions seems to suggest that locational advantages can still be a source of productivity gain for firms. Even if traditional reasons for clustering might have diminished in importance with globalisation, new motivations for proximity to customers and competitors have arguably grown in importance in an increasingly complex, knowledge-based economy. This seems to suggest some qualification of the hypothesis that many of the drivers of economic change are leading to the "death of distance" (Cairncross, 1997) and "flattening" (Friedman, 2002) of the world economy.

The objective of this report is to ascertain to what extent public policy can seize opportunities that these evolutions offer. This involved addressing how regions react to the changes in their economic structures brought about by globalisation and the policy implications with respect to key policy domains such as capital investment and innovation promotion. The issues were addressed through the lens of the ongoing transformation of key industries, both mature and high-growth sectors, in advanced and less advanced regions. This synthesis report is based on a number of different inputs:

1. A review of national policies in OECD countries to support regional clusters, published separately as Competitive Regional Clusters: National Policy Approaches (OECD, 2007a).

2. A literature and data review focusing on the evolution of regional economies and how the main trends and drivers of globalisation may affect regions (using the OECD's regional database).

3. Sector studies examining current trends and future evolutions in three global industries (ICT, automotive and biopharmaceuticals).

4. Twelve region-sector case studies based on interviews with policy makers and other economic actors in regions that are specialised in these industries (see "Introductory Note: Case Study Selection").

This report is part of the work by the OECD's Territorial Development Policy Committee on regional competitiveness and innovation-led policies for regions, and has been conducted in close co-operation with the OECD International Futures Programme (IFP) in the Secretary-General's Advisory Unit. The project was co-sponsored by Nutek, the Swedish Agency for Economic and Regional Growth, which manages a number of initiatives aimed at regional competitiveness and, more specifically, cluster development.

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Table of Contents

• • •

List of boxes

List of tables

List of figures

ISBN 978-92-64-03779-3
Globalisation and Regional Economies:
Can OECD Regions Compete in Global Industries?

Executive Summary

A dynamic and uncertain policy context

Economic geography in an era of global competition involves a paradox. It is widely recognised that changes in technology and competition have altered many of the traditional rules that determine location of economic activity, making it possible for firms to access the inputs and knowledge that they need in order to compete from anywhere across the globe. Yet geographic concentration remains a striking feature of virtually every national and regional economy in the OECD. Over the last few years, for example, many of the leading firms in "new economy" industries have tended to cluster together.

This report argues that behind this apparent paradox there are some long-term evolutions that will over time change the location equations that influence how economic activities are distributed both within countries and across the globe. Some of the key trends that are driving this process include:

- Increasingly complex global production networks that link global brand leaders, contract manufacturers and specialised component producers.
- Extension of offshoring of manufacturing from industries such as textiles and ICT in which Asia has already become the "global factory" to high-tech industries and to new segments of the production process.
- Fundamental changes in corporate strategies, giving rise to more open and networked corporate innovation systems with strong region-level and global dimensions.
- Innovation offshoring leading to the emergence of R&D clusters in non-OECD countries.

These trends have important consequences for policy makers at both national and regional level. These relate both to how to attract and retain key investments in their current locations, and how to build on existing locational advantages.

How are OECD regional economies changing?

Given that many OECD regions are closely associated with industrial production and often with specific industries, rapid evolutions in economic structures cause concern among both policy makers and citizens in OECD countries. Issues such as delocalisation, jobless growth, job insecurity and the replacement of high-wage, skilled manufacturing jobs with lower-wage service jobs are high on the political agenda in many OECD countries.

The productive structures of OECD regions have undoubtedly altered dramatically, at a rapid pace and in a manner that has clear policy implications. Regional economies have evolved away from manufacturing production toward knowledge-intensive service activities.

One of the most striking changes has been the reduction in the prominence of manufacturing as a source of employment and the emergence of service jobs as the cornerstone of most regional economies. Between 1998 and 2004, for example, most regions experienced large job losses in manufacturing (an average of over 20 000 manufacturing jobs disappeared in each OECD region, 30 000 in each G7 region). These job losses were usually, but not always, offset by growth in service employment. On average, between two and three service jobs were created for every manufacturing job lost over the period. In some of the more dynamic regions, the ratio was ten or more new service sector jobs for each manufacturing job lost.

The process of deindustrialisation has focused attention on knowledge-intensive services. OECD regions retain strong headquarter functions, R&D, design, marketing, software and support services, and other high value added service activities, with or without production. These knowledge-intensive services are often closely related to manufacturing. In many cases regional specialisation continues but without the production components. For example, the ICT industries in both Stockholm and Ottawa are predominantly based on service activities (software, applications, systems support, etc.) that have grown out of the specialisations of the two regions in fixed and mobile telecommunications equipment manufacturing. The same process of expansion in related services activities can be seen even in regions that are still strong in production. The increase in ICT-enabled offshoring of some higher skill service occupations (software development or web design, for example) suggests, however, that some functions that were formerly difficult to outsource reliably can now be managed at distance.

A major part of the concern over the future of manufacturing in the OECD is explained by a perception that what OECD regions can offer in terms of skills, business environment, etc., has ultimately become less valuable to global firms than what they can get from lower wage economies where competencies are increasing rapidly. However, although firms have fewer and fewer constraints on where they locate, strong patterns of concentration and specialisation persist at national and regional level. The tendency towards concentration rather than dispersion is clear for both medium- and high-technology industries. Evidence from this project supports the view that localised knowledge spillovers (due to inter-firm linkages, a versatile labour pool, strong innovation-related infrastructures, etc.) can be a tangible source of productivity gain for firms and can constitute a persuasive argument against relocation or in favour of investment. For example, even as the Detroit region experiences ongoing restructuring and manufacturing job losses, the accumulated research capacities in the region continue to draw in R&D-related investment.

The concentration of innovation-related assets is also striking. The ten leading regions in Europe in terms of GDP per capita account for more than one-third of all patents. Moreover, there is a very strong link between certain characteristics of regional economies and innovation. For example, the level of patenting activity is strongly correlated with GDP per capita (correlation coefficient of 0.86, significant at the 0.05 level), with students in higher education (correlation coefficient, 0.81), and with employment in high-technology industries (correlation coefficient, 0.85). There is also evidence of specialisation across leading regions with respect to the types of patent and sectors of activity (as shown by the strong position of the Eindhoven region in innovation in the semiconductor and materials engineering fields and of Stockholm in ICT innovation).

Given that regional economies are often closely linked to a limited number of key industries, the performance of those sectors has an important influence on regional performance overall. Because of its high productivity and wage levels, manufacturing jobs are estimated to support around 3 to 4 non-manufacturing jobs each. The figure for one automotive region was estimated to be 1:10. As such, the impact of changes in industrial employment can be dramatic for regions. The declines in employment in textile and clothing industries have had serious consequences for many OECD regions because these sectors are among the most geographically concentrated industries (over 40% of employment in each sector in Europe and the US is geographically concentrated). At the same time, the automotive, pharmaceuticals and branches of the ICT industry are also similarly clustered, and the growth of these industries has, in turn, boosted regional economic growth in these places. Anticipating changes in demand by sector is thus a key dimension of the process of economic policy making at regional level.

A key regional development issue for policy makers is the extent to which competitive manufacturing and related service industries can be maintained outside the core regions in which they currently concentrate. While two of the regions included in this report (Eindhoven and Stockholm) are responsible for more than 300 patent applications per million inhabitants in ICT industries per year, one-third of EU regions recorded less than one patent per million inhabitants in 2000. Three-quarters of the US biotechnology industry is located in just five urban centres, even though 41 out of 50 US states have established significant funding programmes to spur development of the life sciences industry. This last example suggests that in some cases regional strategies based on building specialisations in R&D and innovation intensive activities is not the best option where there is inadequate critical mass or where the leading regions have agglomeration advantages that are too significant.

Even though this project does not provide evidence to suggest that any region can develop entirely new specialisations in high-growth industries, it does nonetheless demonstrate that regions can transform existing specialisations in mature industries into higher growth activities in related sectors (both manufacturing and service-based). Examples of such transitions included the transition from telephone handset production to mobile Internet system design or from vehicle production to GPS, road sensing and safety equipment. In each case these evolutions depended on strong awareness of the changing market environment and the relative competitive advantage of different places in global production systems.

How are the drivers of globalisation influencing regional economies?

The processes of change in regional economies are often attributed to globalisation, usually in terms of the threats posed by opening of markets, and, less frequently, with respect to the opportunities that globalisation offers. This research supports other OECD work that indicates that deindustrialisation for most regions and in most sectors is more closely linked to productivity gains from technological advances and industry-level restructuring than to competition from low-wage economies as such. The recent crises that have hit industrial regions examined in this report seem to have more to do with sector-specific shocks, such as the crash in ICT-related stock values in 2000-01 or the slump in sport utility vehicle (SUV) sales in the US market, than to more direct drivers of globalisation.

The decisions of MNEs and the knock-on effects that these have on regions are often the most visible link between regional economies and globalisation. MNEs have been major beneficiaries of globalisation, which has allowed them to access new markets and to reorganise production in new ways. It is clear from the regions studied that globalisation helped the expansion of the regions' MNEs and has thus created large numbers of local jobs. The specialisation of the regions and the growth of "clusters" of firms and skilled labour pools in these regions (the factors that seem to drive knowledge spillovers) have been, in large part, driven by the growth of the local MNEs.

Recently, MNEs have had a more mixed impact on their "home base" regions. The search for more efficient business models has in some cases redefined long-established local ties. Downsizing, M&A, break up of large firms and market-motivated relocations of HQs all appear to have loosened the bonds between anchor firms and the region. These reconfigurations result not only in job losses in many cases but also alter the relationship between large firms and other local actors. For example, the takeover of Pharmacia by Pfizer, of Nortel by Alcatel and of Volvo Cars by Ford have all had important consequences for workers and businesses in Stockholm, Ottawa and Västra Götaland respectively, and have (potentially) undermined the ability of regional (and also national) policy makers to influence business decisions that have an impact on the regional economy.

Nonetheless, reorganisation of production by MNEs has had some positive side-effects, despite the socio-economic upheavals involved. For example, outsourcing of increasingly important segments of production by MNEs is broadening the structure of regional economies by changing the relationships within regional supply chains, making them more open and outward looking. A decade ago, the large majority of suppliers to Fiat in Turin, like suppliers in other case study regions, were dedicated suppliers with one major customer. Now most suppliers in the region have wider and more diverse client bases, although this transition has been a difficult one in the case of the automotive components industry.

Despite the global reach of large firms, new business models in some cases put more emphasis on region-level collaboration among firms, particularly in the field of innovation. Large firms are under pressure to innovate their products and develop and assimilate new technologies rapidly. Firms in dynamic, research-intensive fields like ICT or biopharmaceuticals often cannot do this effectively through their traditional internal innovation structures and have seen the productivity of in-house R&D decline. This is partly because many of the most important product innovations in a particular industry involve adapting and integrating technology from other industries. In some cases, this demand for cross-disciplinary expertise is met by large companies such as Microsoft and Apple which work extensively with telecom equipment manufacturers and car makers. But it is also an opportunity for SMEs who can often be more agile in adapting existing technologies. For example, small firms are often more aware of niches or emerging markets and may find solutions to new legal or regulatory requirements.

For these reasons, regional systems of innovation are becoming increasingly complex in terms of both the types of actors involved and the range of industries or technologies that are present. More open innovation systems, in which innovation occurs outside the normal boundaries of individual firms, is becoming an important tool by which both large and small firms can share the risk of generating new products. The regions studied demonstrate that there are still strong advantages to a regional system of innovation that

uses proximity to build the kinds of trust-based relationships on which open innovation and other forms of networked innovation depend.

At the same time, global networks are an unavoidable part of the world economy. Although until now these networks have been focused on production, the global networking of innovation is starting. As such, innovation offshoring poses a threat to OECD regions that see knowledge assets as their principal competitive advantage. While currently non-OECD countries conduct R&D in limited segments of the overall product development process, there are examples where R&D labs in more advanced regions in India and China are responsible for the entire product development process.

Once "upstream" facilities are established in specific locations in emerging markets, there appears to be a tendency to move to more demanding projects (in terms of greater integration of tasks and growing technological complexity). In order for MNEs to be able to recruit and retain key talent, they need to provide increasingly demanding projects. While MNEs used to dominate markets for top talent in China and India, they now need to compete with local firms. The increasing importance for MNEs of designing products that respond directly to the large markets in non-OECD countries is likely to speed up this process.

In other words: once local cluster development reaches a critical mass, there seems to be a qualitative change. A few years ago, survey research in China and India found a consensus that "the capacity to support and sustain core research is still relatively underdeveloped here", even in first-tier locations like Shanghai or Bangalore. That consensus has now been eroded. The issue now is whether (or how quickly) key firms (MNEs and domestic firms) in these locations will locate more demanding functions to these locations (Ernst, 2006). In these cases, lead firms will have a vested interest in seeing the density of the local innovation system or cluster increase. Several of the case study regions reported that local manufacturing firms had been bought up by either Chinese and Indian firms, probably in order to access technology and operational expertise in domestic hubs. In this respect, further work looking at the innovation system dynamics in places like Beijing, Shanghai, Shenzhen, Suzhou, Hangzhou and Nanjing (in China), and in Bangalore, Delhi, Mumbai, Pune, Chennai, Hyderabad and Ahmedabad (in India) would be relevant for policy makers in OECD regions.

How can OECD regions compete?

The concern of policy makers is to understand how resilient regional economies are. For example, the ability of Ottawa and Stockholm to recover both output and employment lost during the ICT crisis is a sign of their adaptability, although in each case the restructuring has fundamentally altered the nature of the activities carried out in the region. The performance of the major car manufacturing regions in Europe and North America – which are still strongly oriented towards production – will offer more evidence of whether traditional sectors can be restructured as industrial locations, in spite of concerns about the pressure of global competition.

The response of the regions to these evolutions takes a variety of forms, some more explicit than others. Often a compelling problem or crisis serves as the trigger for co-ordinated action, and there is a strong risk of complacency when regions fail to anticipate future trends because current indicators are positive.

A clear and systematic analysis of the region's economy and assets in the context of global trends is the basis for any potential regional action. This analysis requires a clear understanding of the changing roles of different categories of firms (start-ups, SMEs, multinationals, etc.) and their role in global supply chains. However, the data are often at too large a scale and do not capture the very localised dimension of the knowledge spillovers that policy should be targeting (evidence from the US points to a rapid decline in the positive spillover effect with distance).

Perhaps the most important role for regional strategies is to favour adaptation to change. While public actors are not well-placed to predict the future, they can play a clear role in developing an environment that supports private actors in their efforts to adapt and seize opportunities. Tools are needed both to understand and monitor how research and educational assets interact with enterprises with the goal of designing policies to help build more systematic linkages across all actors.

In terms of the specific targets for policy, the research suggests at least six main policy objectives that regions should be focusing on. These are closely interrelated, but they highlight the different dimensions of regional competitive advantage that policy makers are trying to enhance and illustrate the main region-specific assets on which regional policy makers are building their strategies.

Table 0.1. **Summary of policy objectives**

Regional asset	Objectives
Supporting firms	
Existing specialised firms	Broadening the customer base of specialised firms; reducing their dependence on MNEs, helping them to reach global markets.
Innovative small firms	Supporting small firms with technical facilities, linking them to venture capital and other finance, helping to create networks among small firms.
MNEs	Embed certain functions/activities of MNEs in the region through stronger supply chains and a richer regional environment, support interaction between large firms and innovative small firms.
Improving the regional environment	
Cross-over technology	Reducing dependence on single industry by identifying cross-over or enabling technologies; finding new applications for sector-specific technologies.
Regional innovation system	Promoting linkages between economic actors through co-location (science parks, etc.), strengthening the applied research dimension of public R&D facilities, supporting open innovation mechanisms.
Other measures of regional attractiveness	Infrastructure, ensuring that skills supply is appropriate, limit brain drain and try to attract skilled people.

Evidence points to a continued value for regions to offer cluster-specific support in addition to strengthening the overall regional environment. Firms valued public support in marketing, especially to attract venture capital, and targeted public investments that fill gaps in the innovation/commercialisation process, which often require a sector-specific approach. The regions emphasised that these instruments were not "inward-looking" but were designed to help firms reach wider markets and production networks. Global firms seek out the concentration of assets that they find in certain regions as well as systems in place that have a proven capacity to generate innovation. As such, there is a close policy link between cluster policies and efforts to build regional innovation systems.

Résumé

Un cadre d'action publique dynamique et incertain

À l'ère de la concurrence mondiale, la géographie économique conduit à un paradoxe. Il est largement admis que le progrès technique et l'évolution de la concurrence ont modifié nombre des règles qui déterminaient la localisation des activités économiques, donnant aux entreprises accès aux moyens de production et aux connaissances dont elles ont besoin pour affronter la concurrence à travers le monde. Or, la concentration géographique reste une caractéristique frappante pour pratiquement toutes les économies régionales et nationales de la zone de l'OCDE. Depuis quelques années, beaucoup d'entreprises leaders du secteur de la « nouvelle économie » tendent à se regrouper en pôles d'activité.

Ce rapport tend à montrer qu'en réalité ce paradoxe cache certaines évolutions à long terme qui, avec le temps, changeront les « équations » de localisation qui influent sur la répartition des activités économiques, tant au niveau national qu'au niveau mondial. Parmi ces tendances fondamentales, on citera les suivantes :

- Des réseaux mondiaux de production de plus en plus complexes qui associent les grandes marques mondiales, les sous-traitants et les producteurs de composants spécialisés.
- Le développement de la délocalisation dans certaines branches, comme celles du textile et des technologies de l'information et de la communication (TIC) pour lesquelles l'Asie est déjà devenue « l'usine globale », gagne aujourd'hui les activités de haute technologie et de nouveaux segments du processus de production.
- Des changements fondamentaux dans les stratégies des entreprises, donnant naissance à des mécanismes d'innovation plus ouverts et plus souvent constitués en réseaux comportant de fortes dimensions à la fois globale et régionale.
- La délocalisation de l'innovation suscitant l'émergence de pôles de R-D dans les pays non membres de l'OCDE.

Ces tendances sont lourdes de conséquences pour les responsables des politiques, tant au niveau régional qu'au niveau national. Elles portent à la fois sur les moyens d'attirer et de retenir les investissements essentiels sur leur site, en s'appuyant sur les avantages qu'offre leur implantation.

Comment les économies régionales de l'OCDE évoluent-elles ?

Étant donné que de nombreuses régions de l'OCDE sont étroitement associées à la production industrielle et souvent avec des branches précises, l'évolution rapide des

structures économiques suscite l'inquiétude des autorités et des citoyens dans les pays de l'OCDE. Certaines questions, comme les délocalisations, la croissance sans création d'emplois, la précarité de l'emploi et le remplacement d'emplois qualifiés et bien rémunérés de la production par des emplois à plus bas salaire du secteur des services, figurent parmi les priorités des préoccupations des responsables politiques dans de nombreux pays de l'OCDE.

Il est hors de doute que les structures productives des régions de l'OCDE se sont modifiées de façon spectaculaire, à un rythme rapide et d'une manière qui appelle des mesures précises de la part des autorités publiques. Les économies régionales se sont éloignées des activités manufacturières pour passer à des activités à forte intensité de savoir. L'un des changements les plus frappants a été la moindre importance de l'industrie de transformation comme source d'emplois et l'émergence des emplois dans les services comme clé de voûte dans la plupart des économies régionales. Ainsi, entre 1998 et 2004, la plupart des régions ont subi de fortes pertes d'emplois dans l'industrie de transformation (en moyenne, plus de 20 000 emplois ont disparu dans chaque région de l'OCDE, plus de 30 000 dans chaque région du G7). Ces pertes d'emploi étaient en règle générale, mais pas toujours, compensées par la croissance de l'emploi dans le secteur des services. En moyenne, sur cette période, entre deux et trois emplois étaient créés dans le secteur des services pour chaque emploi perdu dans l'industrie de transformation. Dans certaines régions parmi les plus dynamiques, ce rapport atteignait ou dépassait dix emplois nouveaux dans le secteur de services pour chaque emploi perdu dans l'industrie de transformation.

Avec le processus de désindustrialisation, l'attention s'est focalisée sur les services à forte intensité de savoir comme avantage concurrentiel régional. Les régions de l'OCDE conservent d'importantes fonctions de siège social, de R-D, de conception, de commercialisation, de services informatiques et logistiques, ainsi que d'autres activités de service à forte valeur ajoutée. Ces services à forte intensité de savoir sont souvent étroitement liés à l'industrie de transformation. Dans de nombreux cas, la spécialisation régionale se poursuit, mais sans les composantes de production. Par exemple, les activités relatives aux TIC, à Stockholm et à Ottawa, reposent principalement sur des activités de service (logiciel, applications, logistique des systèmes, etc.) qui se sont développées à partir des spécialisations des deux régions dans la production d'équipements de télécommunications fixes et mobiles. Le même phénomène d'expansion des activités connexes de services peut s'observer, même dans les régions qui conservent une forte activité de production. L'augmentation de la délocalisation de certains services nécessitant de fortes compétences dans le domaine des TIC (développement des logiciels ou de la conception sur Internet) montre cependant que certaines fonctions qu'il était auparavant difficile de délocaliser peuvent à présent être gérées à distance.

Une grande partie de l'inquiétude sur l'avenir de l'industrie de transformation dans les pays de l'OCDE s'explique par l'idée que les atouts des régions de l'OCDE en matière de qualifications, d'environnement de l'entreprise, etc., ont en définitive moins de valeur pour les entreprises mondiales que ce qu'elles peuvent obtenir dans les économies à bas salaires où les compétences progressent rapidement. Toutefois, bien que de moins en moins de contraintes pèsent sur les décisions de localisation des entreprises, de fortes caractéristiques de concentration et de spécialisation persistent au niveau régional. La tendance à la concentration plus qu'à la dispersion est nette, que les activités soient de haute technologie ou de technologie intermédiaire. Les observations recueillies lors de ce

projet corroborent la thèse selon laquelle les retombées locales du savoir (du fait des liens qui unissent les entreprises, d'une réserve polyvalente de main-d'œuvre, des infrastructures fortement liées à l'innovation) peuvent offrir aux entreprises une source matérielle de gains de productivité et cela peut constituer un argument convaincant contre la délocalisation ou en faveur de l'investissement. Par exemple, même si la région de Detroit subit une restructuration permanente et des pertes d'emplois dans la production, les capacités de recherche accumulées dans la région continuent d'attirer l'investissement dans la R-D.

La concentration des actifs liés à l'innovation est également surprenante. Les régions les plus performantes en Europe en termes de PIB par habitant sont responsables de plus d'un tiers de la production totale de brevets. Par ailleurs, il existe de forts liens entre certaines caractéristiques des économies régionales et l'innovation. Par exemple, le niveau des activités de brevets est fortement corrélé au PIB par habitant (coefficient de corrélation de 0.86, significatif à 0.05) et au nombre d'étudiants dans l'enseignement supérieur (coefficient de corrélation de 0.86, significatif à 0.05). Des données montrent également la présence d'une spécialisation des régions leaders en termes de secteurs d'activité (comme le démontre la forte position qu'occupe la région d'Eindhoven en matière d'innovation dans les secteurs des semi-conducteurs et de conception de nouveaux matériaux ou celle de Stockholm dans le secteur de TIC).

Comme les économies régionales sont fortement liées à un nombre limité d'industries clés, la performance de ces secteurs exerce une forte influence sur la performance globale de ces économies. Du fait de sa productivité et de ses niveaux de salaire élevés, on estime que chaque emploi dans le secteur manufacturier soutient autour de trois à quatre emplois non manufacturiers. Ce ratio pour une région spécialisée dans l'industrie automobile s'élève à 1 pour 10. Dans ce contexte, l'impact des changements dans l'emploi industriel peut être conséquent pour les régions. Le déclin de l'emploi dans le secteur du textile et de l'habillement a eu de sérieuses conséquences pour de nombreuses régions de l'OCDE, ces secteurs étant parmi les plus géographiquement concentrés au niveau régional (plus de 40 % de l'emploi dans ces secteurs en Europe et aux États-Unis est géographiquement concentré). Les secteurs de l'automobile, de l'industrie pharmaceutique, et des TIC se sont regroupés de manière similaire, et la croissance de ces industries a stimulé en retour la croissance économique régionale de leurs régions d'implantation. Anticiper les changements de la demande par secteur s'avère donc essentiel pour aider le choix des politiques économiques à une échelle régionale.

La question essentielle pour les décideurs de l'action publique en matière de développement régional est de savoir dans quelle mesure une industrie de transformation compétitive et ses activités de services connexes peuvent se développer hors des régions centrales où elles se concentrent aujourd'hui. Tandis que deux des régions étudiées dans ce rapport, Eindhoven et Stockholm, étaient en 2000 à l'origine de plus de 200 demandes de brevet par million d'habitants dans le secteur des TIC, un tiers des régions de l'Union européenne ont enregistré moins d'un brevet par million d'habitants. Les activités de biotechnologie aux États-Unis sont situées pour les trois-quarts dans cinq centres urbains seulement, bien que 41 des 50 États des États-Unis aient mis en place d'importants programmes de financement pour stimuler le développement des sciences de la vie. Ce dernier exemple montre que dans certains cas, les stratégies de développement régional fondées sur le développement de spécialisations en R&D et les activités à forte intensité d'innovation ne sont pas le meilleur choix, lorsque la masse critique nécessaire est

insuffisante ou quand les régions motrices ont des avantages d'agglomération qui sont déjà trop importants.

Bien que ce projet ne démontre pas que les régions peuvent développer de nouvelles spécialisations dans les industries de haute technologie, il montre néanmoins que les régions peuvent transformer les spécialisations existantes dans les industries matures en activités à forte croissance dans les secteurs connexes (aussi bien dans l'industrie de transformation que dans les services). Le passage de la production de téléphones fixes au système Internet ou celui de la production automobile au GPS, équipement de reconnaissance et de sécurité routière, sont des exemples réussis de ce type de transition. Dans chacun des deux cas, les évolutions dépendaient de la sensibilisation aux évolutions du marché et de l'avantage compétitif de chaque unité de production dans le système global de production.

Comment les ressorts de la mondialisation influent-ils sur les économies régionales ?

Les mécanismes du changement dans les économies régionales sont souvent attribués à la mondialisation, en général sur la base des périls que comporte l'ouverture des marchés et, moins fréquemment, compte tenu des possibilités qu'offre la mondialisation. Cette étude vient à l'appui d'autres travaux de l'OCDE selon lesquels la désindustrialisation, dans la plupart des régions et la plupart des secteurs, est plus étroitement liée aux gains de productivité découlant du progrès technique et de la restructuration au niveau des branches d'activité qu'à la concurrence des économies à bas salaire en tant que telle. Les crises qui ont récemment frappé les régions industrielles examinées dans ce rapport semblent tenir davantage à des chocs sectoriels, comme l'effondrement du prix des actions dans le secteur des TIC en 2000-01 ou la chute des ventes de véhicules utilitaires de sport sur le marché des États-Unis, qu'aux ressorts directs de la mondialisation.

Les décisions des entreprises multinationales et l'impact dynamique qu'elles exercent sur les régions sont souvent le lien le plus évident qui unit la mondialisation et les économies régionales. Les entreprises multinationales figurent parmi les principales bénéficiaires de la mondialisation, qui leur a permis d'accéder à de nouveaux marchés et de réorganiser leur production selon de nouveaux modes. Des régions étudiées, il ressort nettement que la mondialisation a favorisé l'expansion des entreprises multinationales de ces régions, créant ainsi un grand nombre d'emplois locaux. La spécialisation des régions et le développement des « grappes » d'entreprises et des réservoirs de main-d'œuvre qualifiée dans ces régions (facteurs qui semblent entraîner la diffusion des connaissances) ont été, en grande partie, induites par la croissance des entreprises multinationales locales.

Récemment, les entreprises multinationales ont exercé des effets plus mitigés sur leur région « d'origine ». La recherche de modèles d'entreprise plus efficients a parfois entraîné une redéfinition d'attaches locales établies de longue date. La réduction des effectifs, les fusions-acquisitions, le démembrement de grandes sociétés et les transferts de siège social motivés par des impératifs de marché sont autant de facteurs qui paraissent avoir distendu les liens des entreprises souches avec leur région. Ces restructurations ne se traduisent pas seulement par des pertes d'emplois dans de nombreux cas, elles modifient aussi les rapports des grandes entreprises et des autres acteurs locaux. Par exemple, la reprise de

Pharmacia par Pfizer, de Nortel par Alcatel et de Volvo par Ford a, à chaque fois, entraîné d'importantes conséquences pour les travailleurs et les entreprises respectivement à Stockholm, Ottawa et Västra Götaland. Les restructurations peuvent aussi potentiellement compromettre la capacité des décideurs régionaux (et aussi nationaux) d'influer sur les décisions des entreprises qui ont un impact sur l'économie régionale.

Néanmoins, la réorganisation de la production par les entreprises multinationales a exercé certains effets secondaires positifs, malgré les bouleversements socioéconomiques qu'elle a entraînés. Par exemple, la sous-traitance de segments de plus en plus importants de la production par les entreprises multinationales élargit la composition des économies régionales en modifiant les relations dans les chaînes régionales de l'offre, les ouvrant davantage et les tournant vers l'extérieur. Il y a dix ans, la grande majorité des fournisseurs de Fiat à Turin, comme ceux des autres régions retenues pour les études de cas, étaient des fournisseurs spécialisés avec un seul client principal. Aujourd'hui, la plupart des fournisseurs de la région ont une clientèle élargie et diversifiée, même si cette évolution a été douloureuse dans le cas de la branche des équipements pour l'automobile.

En dépit du rayonnement mondial des grandes entreprises, les nouveaux modèles d'entreprise privilégient parfois la collaboration entre les entreprises à l'échelon régional, notamment dans le domaine de l'innovation. Les grandes entreprises se doivent d'innover, de mettre au point et d'assimiler rapidement de nouvelles techniques. Les entreprises des secteurs dynamiques où la recherche est intense, comme les TIC ou les produits biopharmaceutiques, ne peuvent le faire efficacement par les circuits internes classiques de l'innovation et ont vu baisser la productivité de leur R-D interne. Cela tient en partie au fait qu'un grand nombre d'innovations de produit, parmi les plus importantes dans chaque branche d'activité considérée, suppose l'adaptation et l'intégration de la technologie d'autres branches. Certaines grandes entreprises, par exemple Microsoft et Apple, répondent à cet impératif de pluridisciplinarité par une collaboration massive avec les fabricants d'équipements de télécommunications et les constructeurs automobiles ; mais c'est aussi une possibilité qui s'offre aux PME, car elles peuvent souvent se montrer plus habiles dans l'adaptation des technologies existantes. Ainsi, les petites entreprises sont souvent plus au fait des créneaux porteurs ou des marchés émergents et peuvent trouver des solutions à de nouvelles exigences légales ou réglementaires.

Dans certains cas, la réduction des effectifs des grandes entreprises a libéré des talents d'entrepreneur qui ont trouvé à s'investir dans de nouvelles jeunes pousses, lesquelles sont devenues depuis lors de véritables laboratoires régionaux de technologie. Ce phénomène semble encouragé, implicitement au moins, par les entreprises multinationales dans le cadre d'une stratégie générale de veille de l'innovation dans les réseaux régionaux et de recherche de partenaires, y compris des PME, avec lesquelles elles partagent les risques que comporte le développement de la technologie ou des produits.

Pour ces raisons, les systèmes régionaux d'innovation se complexifient, tant par la multiplication des catégories d'intervenants que par l'éventail des activités ou des technologies en présence. L'ouverture des systèmes d'innovation, par laquelle l'innovation se produit hors des murs de chaque entreprise, devient un instrument important par lequel les entreprises, grandes et petites, peuvent partager le risque de la création de produits. Les régions étudiées montrent qu'il subsiste de sérieux avantages à un système régional d'innovation qui exploite la proximité pour établir les rapports fondés sur la confiance dont dépendent l'innovation ouverte et les autres formes d'innovation en réseau.

En même temps, les réseaux mondiaux font inévitablement partie de l'économie mondiale. Bien que, jusqu'à présent, ces réseaux aient été axés sur la production, la mise en réseaux mondiale de l'innovation a commencé. C'est pourquoi la délocalisation de l'innovation met en péril les régions de l'OCDE qui considèrent le savoir comme leur principal avantage concurrentiel. Si, aujourd'hui, les pays non membres de l'OCDE ne mènent la R-D que sur des segments limités du cycle de développement des produits, on trouve dans les régions les plus avancées de l'Inde et de la Chine des exemples de laboratoires de R-D chargés du cycle entier de développement des produits.

Une fois que les laboratoires de R-D sont établis dans des régions spécifiques sur les marchés émergents, une tendance semble émerger en faveur de projets plus exigeants (avec une plus forte intégration des tâches et une complexité technologique accrue). Afin de pouvoir recruter et retenir les talents, les entreprises multinationales ont besoin de fournir des projets plus exigeants. Alors que les entreprises multinationales dominaient le marché des talents en Chine et en Inde, elles doivent maintenant affronter la concurrence des entreprises locales. L'importance croissante pour les entreprises multinationales de créer des produits qui correspondent directement aux larges marchés des pays non membres de l'OCDE est à même d'accélérer ce processus.

Dit autrement, cela signifie qu'une fois que le développement d'un pôle d'activités locales a atteint une masse critique, il semble y avoir un saut qualitatif. Il y a quelques années, les recherches sur la Chine et l'Inde montraient que « la capacité de supporter et de soutenir la recherche fondamentale était encore sous-développé (dans ces pays-ci) », même pour des localisations de premier choix comme Shanghai ou Bangalore. Ce n'est plus le cas aujourd'hui. La question est maintenant de voir comment (et à quel rythme) ces entreprises leaders (multinationales et firmes locales) vont-elles implanter ces fonctions plus exigeantes dans ces localisations (Ernst, 2006). Dans ce cas, les entreprises leaders auront tout intérêt à considérer la densité du système local d'innovation et des « grappes » d'entreprises. Dans le cas de ce projet, des études de cas régionales notent que les entreprises locales de fabrication et transformation ont été rachetées par des entreprises chinoises et indiennes, sûrement pour avoir accès à des technologies et des expertises opérationnelles dans des centres locaux. Dans cette perspective, se pencher davantage sur les dynamiques des systèmes d'innovation dans des lieux comme Beijing, Shanghai, Shenzhen, Suzhou, Hangzhou et Nanjing (en Chine), et sur Bangalore, Delhi, Mumbai, Pune, Chennai, Hyderabad et Ahmedabad (en Inde) est pertinent pour les acteurs politiques des régions de l'OCDE.

Comment l'OCDE peut-elle faire face à la concurrence ?

La préoccupation des décideurs est de prendre la mesure de la capacité d'adaptation des économies régionales. Par exemple, l'aptitude d'Ottawa et de Stockholm à retrouver à la fois la production et l'emploi perdus pendant la crise des TIC est un signe de leur adaptabilité, encore que, dans chaque cas, la restructuration a fondamentalement modifié la nature des activités réalisées dans la région. Les résultats obtenus par les principales régions d'industrie automobile en Europe et en Amérique du Nord (qui restent résolument axées sur la production) permettront de vérifier plus sûrement si les secteurs traditionnels peuvent être restructurés en sites industriels, malgré les inquiétudes que suscite la pression de la concurrence mondiale.

La réponse des régions à cette évolution prend de multiples formes, certaines plus explicites que d'autres. Souvent, c'est une urgence ou une crise qui déclenche une action coordonnée, et le risque d'excès d'optimisme est élevé lorsque les régions négligent de prévoir l'évolution de la situation en raison d'indicateurs présents favorables.

Une analyse précise et systématique de l'économie et des atouts régionaux dans le contexte des tendances mondiales est le point de départ de toute action régionale envisageable. On dispose d'assez peu de données régionales pour aider les décideurs, notamment du fait de la difficulté de définir une région, et les données nationales sont elles mêmes limitées. Les données quantitatives et qualitatives sont utiles à l'élaboration d'une analyse précise qui permet de savoir quels atouts sont durables et où de nouvelles perspectives pourraient s'ouvrir. Cette analyse suppose aussi une connaissance précise de l'évolution du rôle des différentes catégories d'entreprises (jeunes pousses, PME, multinationales, etc.) et de leur rôle dans les chaînes mondiales de l'offre. Or, les données sont souvent à trop grande échelle pour que l'on puisse apprécier la diffusion locale des connaissances qui doit être la cible de l'action des autorités (les observations recueillies aux États-Unis montrent que les retombées positives déclinent rapidement avec la distance).

Il se peut que le rôle essentiel des stratégies régionales soit de favoriser l'adaptation au changement. Les intervenants publics ne sont pas les mieux placés pour la prévision dans ce domaine, mais ils peuvent jouer un rôle précis en développant un environnement qui soutient des intervenants privés dans leur effort d'adaptation et d'exploitation des nouvelles opportunités qui s'offrent à eux. Des instruments sont nécessaires à la fois pour analyser et pour suivre l'interaction avec les entreprises des infrastructures de recherche et d'enseignement, dans le but de concevoir des politiques qui contribuent à établir des relations systématiques entre tous les intervenants.

Les travaux de recherche laissent entrevoir au moins six grands objectifs pour les actions à mener sur lesquels les régions devraient se concentrer. Ces objectifs sont étroitement interdépendants, mais ils mettent en lumière les différentes dimensions de l'avantage concurrentiel régional que les décideurs essaient de promouvoir, et reflètent les principaux atouts régionaux sur lesquels les décideurs régionaux fondent leur stratégie.

Tableau 0.2. **Résumé des objectifs de l'action publique**

Atouts régionaux	Objectifs
Aide aux entreprises	
Entreprises spécialisées existantes	Élargir la clientèle des entreprises spécialisées ; réduire leur dépendance par rapport aux entreprises multinationales ; les aider à atteindre les marchés mondiaux.
Petites entreprises innovantes	Aider les petites entreprises au moyen de centres techniques ; leur donner accès au capital-risque et à d'autres sources de financement ; contribuer à la création de réseaux de petites entreprises.
Entreprises multinationales	Ancrer dans la région certaines fonctions ou activités des entreprises multinationales par le renforcement des chaînes de l'offre et un environnement régional plus riche ; favoriser l'interaction des grandes entreprises et des petites entreprises innovantes.
Promotion de l'environnement régional	
Technologie transferable	Réduire la dépendance à une seule activité par un recensement des technologies transférables ou habilitantes ; trouver de nouvelles applications à des technologies sectorielles.
Système regional d'innovation	Resserrer les liens qui unissent les agents économiques par des implantations communes (parcs scientifiques, etc.) ; renforcer la composante « recherche appliquée » des centres publics de R-D ; favoriser les mécanismes de l'innovation ouverte.
Autres mesures pour l'attractivité régionale	Renforcer l'infrastructure ; s'assurer que les qualifications offertes sont adaptées ; limiter la fuite des cerveaux et essayer d'attirer la main-d'œuvre qualifiée.

Les données empiriques montrent que les régions ont un intérêt permanent à offrir un appui spécifique aux pôles d'activités, en complément de leur action en faveur de l'environnement régional général. Outre la constitution de réseaux et parfois des dispositions d'aménagement urbain, les entreprises apprécient l'appui des autorités dans la commercialisation, notamment pour attirer le capital-risque, et ciblent les investissements publics permettant de remédier aux lacunes du cycle de l'innovation ou de la commercialisation, qui souvent appellent une démarche sectorielle. Les régions soulignent que ces instruments ne sont pas « internes », mais conçus pour aider les entreprises à atteindre des marchés et des réseaux de production plus vastes. Les entreprises mondiales recherchent la concentration d'atouts qu'elles trouvent dans certaines régions, ainsi que l'existence d'un système qui sur place a fait la preuve de sa capacité d'entraîner l'innovation.

Introductory Note: Case Study Selection

With regional economies transforming rapidly in an increasingly global system of production, what can regions do to seize the best opportunities? To answer this question, a better understanding of these trends and what they mean for regions is required. The study considered regions that are specialised in key global industries to see how overall trends play out in practice and how regional actors are responding. In all, 12 case studies were conducted in regions involved in one of three major industries.

The three industries studied (ICT, biopharmaceuticals and automotive) were chosen because they share some important similarities but also have significant differences. First, each sector is a major employer in many OECD countries. Second, the changes in the structure of the industries over the past two decades reflect the evolution of the industrial sector overall. Third, they are similar in having an important innovation and technology component. At the same time, they have different firm and value chain structures, with small firms playing a different role in each. Fourth, the industries tend to be concentrated in particular regions and exemplify the interdependencies that regional economies are often built on. A final important reason for the choice is that these sectors are increasingly interconnected, and illustrate the blurred lines that exist among sectors and between manufacturing and service activities. In each case, the performance of the sector has a strong influence on the performance of the regional economy. As such, they illustrate the common case of regional specialisation with its associated advantages and pitfalls.

Within each of the three sectors, four regions were studied in detail. The case studies were chosen to give an idea of the range of experiences and responses according to some basic criteria. One selection criteria was geographic distribution. For each sector, one Swedish region, another European region, one non-European region, and one non-OECD region were selected. Another criterion in the choice of regions is that of the scale and diversity of the regional economy. The case study regions illustrate different contexts based on the size and economic profile of the region (*i.e.*, diversified metropolitan regions, traditional industrial regions, emerging hubs, etc.).

Table 0.3. **Overview of region-sector case studies**

Region	Population	Key sector(s) studied	Economic weight	Key firm	Key challenges
Diverse metropolitan regions					
Stockholm, Sweden	Stockholm-Mälar region: Approximately 2.5 million	***ICT*** (mobile communications equipment and systems)	> 70 000 employees in Stockholm (7% of the workforce in Stockholm region) 19 000 employees in Kista Science City 6 000 firms in Stockholm 500 firms in Kista	Ericsson	Consolidate the industry post-ICT bubble Improve collaboration between industry and university Increase number of medium-sized firms
	Stockholm-Mälar region: Approximately 2.5 million	***Biopharma*** (biotechnology-based development and drug production)	30 000 employees in Stockholm (2.5% of the workforce in Stockholm-Mälar-region) 1 300 life science firms in Sweden	AstraZeneca Pfizer (former Pharmacia)	Strengthen co-ordination between different government levels, different initiatives and between firms Promote commercialisation
Montreal, Canada	Metropolitan Area: 3.7 million	***Biopharma*** (biotechnology-based drug development)	40 500 employees and 530 life science firms in Montreal	No anchor firm but many large firms have R&D centres in the region	Improve access to venture capital Improve visibility of biotech cluster internationally Keep and attract skilled labour in the region
Large "traditional" industrial regions					
Turin, Italy	Piedmont region: 4.3 million Turin: 2.1 million	***Automotive*** (development and production)	46 300 employees and 472 firms in Piedmont region	Fiat	Broaden supplier networks to reduce dependence on MNEs Broaden and diversify the technology base Improve co-ordination among government organisations
Detroit, United States	Southeast Michigan: 4.9 million State of Michigan: 10.1 million	***Automotive*** (development and production)	223 000 employees (approximately 22% of the workforce in State of Michigan)	GM, Ford and Chrysler	Broaden supplier networks to reduce dependence on MNEs Strengthen the education system and improve co-operation among firms and educational institutions Improve image of Detroit Better capitalise on auto-related technology assets
Medium-sized regions					
Eindhoven, the Netherlands	North Brabant: 2.5 million Eindhoven: 727 000	***ICT*** (embedded systems, semiconductors for ICT)	18 500 employees and 2 000 firms in Eindhoven region	Philips ASML NXP	As a small region, keep and attract skilled labour Increase number of medium-sized firms Strengthen collaboration across levels of government and among public entities
Ottawa, Canada	City of Ottawa: 870 000	***ICT*** (mobile ICT applications software)	80 000 employees and 1 800 firms in Ottawa	Nortel	Improve access to venture capital Build medium sized firm category Improve accessibility (*e.g.*, direct flights to Europe and California)
Västra Götaland (includes Gothenburg), Sweden	Västra Götaland: 1.5 million	***Automotive*** (development and production)	> 50 000 employees and > 200 firms with at least 20 employees (1/3 of the nation's workforce in the automotive sector)	Volvo AB, Volvo Cars, SAAB, SMEs: Autoliv, SKF	Broaden supplier networks to reduce dependence on MNEs Strengthen incentives for entrepreneurship

Table 0.3. **Overview of region-sector case studies** *(cont.)*

Region	Population	Key sector(s) studied	Economic weight	Key firm	Key challenges
North-western Switzerland (NWCH)	Core area: 560 000; extended area 2 280 000	***Biopharma*** (biotechnology based drug development)	27 800 employees in Metrobasel area: Chemical and pharmaceuticals accounts for 10.7% of the workforce in NWCH	Novartis Roche	Strengthen co-operation among cantons and between firms and universities Improve framework conditions, especially for start-ups
Emerging non-OECD regions					
Shanghai, China	Shanghai: Approximately 18 million	***Automotive***	Concentration in Anting Auto City	Shanghai Automotive Industrial Corporation (also has holdings in many joint ventures with MNEs such as Shanghai Volkswagen)	Reform of State Owned Enterprises Greater spillovers from Chinese-MNE joint ventures to domestic firms Increase standards and markets for auto parts suppliers Possible synergies with other auto clusters in close proximity
	Shanghai: Approximately 18 million	***Biopharma***	The predominant part of the biotech sector is located to the Zhin Yang science park in Pudong. > 55 000 employees in the park across ALL sectors, > 3 000 pharmaceutical firms; 200 domestic start-ups	Notable MNEs with R&D in the park incude: Roche, Novartis, GE Healthcare, Boehringer Ingelheim, GlaxoSmithKline, plus related companies such as Du Pont and Estée Lauder	Greater spillovers from MNEs to domestic firms Support firm needs for commercialisation Support growth of domestic firms Address intellectual property issues Financing sources, including venture capital
Recife, Brazil	State of Pernambuco: 3.8 million Greater Recife: 3.1 million	***ICT*** (systems software)	7 200 employees in Recife metropolitan area and 300 employees in Porto Digital 600 firms in Recife and 100 firms in Porto Digital	No anchor firm	Keep and attract skilled people Improve infrastructure Strengthen collaboration among firms and between firms and universities Lack of large firms

PART I

Final Report

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Globalisation and Regional Economies:
Can OECD Regions Complete in Global Industries?

PART I

Chapter 1

The Reshaping of Regional Economies

Rapid changes in economic structures are causing concern among both policy makers and citizens in OECD countries. To understand how these trends are affecting regions, this chapter explores the dynamics of the manufacturing sector at the regional level and the shift, visible in some places, towards higher value manufacturing and non-manufacturing activities. This chapter sets the scene for subsequent discussion of whether and how regions can seize the opportunities offered by globalisation by building on their accumulated assets.

Introduction and key points

Given that many OECD regions are closely associated with industrial production and often with specific industries, rapid evolutions in economic structures cause concern among both policy makers and citizens in OECD countries. Issues such as delocalisation, jobless growth, job insecurity and the replacement of high-wage, skilled production jobs with lower-wage service jobs are high on the political agenda in many OECD countries. To understand how these trends are affecting regions, this chapter first explores the dynamics of the manufacturing sector at the regional level and the shift, visible in some places, towards higher value manufacturing and non-manufacturing activities.

This chapter also reviews the different dimensions of specialisation. A major part of the concern over the future of manufacturing in the OECD is explained by a perception that what OECD regions can offer in terms of skills, business environment, etc., is ultimately less valuable to global firms than what they can get from lower wage economies where competencies are increasing rapidly. Yet geographic concentration of interconnected companies seems to suggest that locational advantages are still a source of productivity gain for firms. Even if traditional reasons for clustering might have diminished in importance with globalisation, new motivations for proximity to customers and competitors have arguably grown in importance in an increasingly knowledge-based economy.

Key points

- OECD regional economies have evolved away from manufacturing production toward other activities. This has involved substantial job losses in manufacturing, usually but not always, offset by growth in service employment, resulting in net job growth. While around 75% of OECD regions had net employment growth (only 70 regions out of 294 saw total employment decline), less than one-third (29%) recorded an increase in manufacturing employment.
- These job losses in manufacturing are mainly a result of productivity gain and restructuring rather than to processes associated more directly with globalisation such as offshoring/delocalisation. As a result, in many regions manufacturing output has grown while manufacturing employment has declined.
- Nevertheless, manufacturing still has a large economic footprint in many regions, including a strong multiplier between industrial jobs and other jobs (up to 1:10 in the auto industry in one region studied). And much of the regional R&D infrastructure is organised around manufacturing and often around specific sectors. In this respect, the performance of the region is still linked to evolutions in industrial sectors.
- Employment change is strongly influenced by the performance of key sectors/industries such as the boom and bust in ICT or market shifts in the auto industry. Patterns of employment change are related to national performance, but there is also significant variation within countries.

- There is some evidence of increasing concentration of high-technology activity and inter-firm linkages. Patent data suggests that there is considerable concentration of high-tech activity, at least across Europe. And there is also significant specialisation among regions in different high-tech sectors/branches.
- There is increasing overlap between technologies used in industrial sectors such as biopharmaceuticals, ICT and auto. And there is also a transition toward knowledge-intensive services linked to these sectors.
- Despite a general shift to knowledge-intensive services, some regions have significant market niches in high value added manufacturing, even in sectors that are vulnerable to offshoring or where job losses have been significant. These knowledge intensive activities are often still related to manufacturing, and in many cases regional specialisation continues, but without the production components.
- Non-OECD regions are becoming important players in these industries. The standard approach is FDI-based but there are also initiatives that aim to build local capacity, including cluster formation.

The decline in manufacturing

Increased output but fewer jobs in most regions

The principal evolution in most OECD regional economies has been the gradual replacement of manufacturing by service industries as their cornerstone. Over the period 1998-2003/4, the share of manufacturing employment as a proportion of total employment across OECD regions fell by around 10%. While around 75% of OECD regions had net employment growth (only 70 regions out of 294 saw total employment decline), less than one-third (29%) recorded an increase in manufacturing employment. In many regions, the scale of the reduction of manufacturing employment was very striking (see Table 1.1). The largest decreases in manufacturing employment (in absolute numbers) were in Japan, the United States and Germany.

To understand better the scale of the evolution in regional economic structures, it is helpful to imagine a typical region.[1] This average regional economy created a positive balance of 61 000 jobs over the period 1998/9-2003/4 and lost an average of

Table 1.1. **Ten regions with the largest absolute declines in manufacturing employment**

Change in employment from 1998-2003/4

	Region	Manufacturing	Total
Japan	Tohoku	–123 808	–266 000
USA	Pennsylvania	–126 499	117 158
USA	Michigan	–126 688	–177 800
USA	Ohio	–128 159	–11 336
Japan	Toukai	–131 587	–96 000
USA	Texas	–136 613	596 682
Germany	Nordrhein-Westfalen	–146 500	–140 000
USA	California	–263 874	892 961
Japan	Kinki	–315 352	–367 000
Japan	Kanto	–567 964	–112 000

Note: Regions listed are at the Territorial Level 2.

20 000 manufacturing jobs. Regions in G7 countries created 60 000 new jobs, but lost an average of over 30 000 manufacturing jobs each.

The reorientation of individual regional economies was often even more dramatic. In many regions, employment growth exceeded manufacturing job losses by a large margin: up to ten or more new jobs created for every one manufacturing job lost. For example, Lombardy (Italy) saw a net decrease of 17 400 industrial jobs over the period, but created over 300 000 net jobs in other sectors. Nord-Pas-de-Calais (France) had a net loss of 13 900 manufacturing jobs but employment increased by around 295 000 jobs over the period. The Mexican state of Puebla lost 22 585 manufacturing jobs but created 359 000 new jobs overall. The US state of Florida saw 42 615 manufacturing jobs disappear, yet total employment grew by 595 000. And the region of West Netherlands lost 19 000 manufacturing jobs but total employment grew by around 250 000. A similar pattern, though often less striking, emerges across many OECD regions.

Even the significant minority of regions that saw manufacturing employment grow tended also to have relatively high total employment growth. Prominent examples include Ontario and Quebec in Canada, Catalonia and Andalusia in Spain and Korea's Capital and Chungcheong regions (see Table 1.2). In most cases, non-manufacturing job growth exceeded manufacturing job growth by a large margin. As a result, the rate of manufacturing employment in the economy declined even in regions where manufacturing employment expanded. The lack of growth of manufacturing employment in regions in some countries that had healthy increases in manufacturing output overall, notably the United Kingdom, the United States and Sweden, illustrate that growth in output can be decoupled from employment growth in manufacturing.

The decline in manufacturing employment in OECD regions has been principally a result of productivity growth and low market demand rather than a direct result of globalisation. In fact, the volume of manufacturing production and the volume of value added in the OECD area have continued to rise over the past decades. However, as a recent OECD report noted, since much of the manufacturing sector has been characterised by relatively high productivity growth, prices of manufacturing products have tended to increase little over time and for certain products have fallen significantly. For example,

Table 1.2. **Ten regions with the highest absolute growth in manufacturing employment**

1998 to 2003/4

	Region	Manufacturing employment growth	Total employment growth	Ratio of manufacturing growth to total employment growth
Canada	Ontario	112 700	683 500	1:6
Korea	Capital region	101 402	1 595 900	1:15
Korea	Chungcheong region	55 172	182 000	1:3
Spain	Catalonia	39 700	477 300	1:12
Spain	Andalusia	38 900	597 500	1:15
Korea	Gyeongnam region	36 883	248 600	1:7
Korea	Gyeonbuk region	34 459	164 900	1:5
Canada	Quebec	28 000	365 800	1:13
Spain	Basque Country	22 600	107 800	1:5
Mexico	Tamaulipas	21 580	130 852	1:6

Note: Regions listed are at the Territorial Level 2.

from 1992 to 2002 productivity measured as output per hour increased by 55% for the US manufacturing sector but by only 29% for the economy as a whole (including manufacturing but excluding agriculture). Prices increased by 140% in the overall US economy but by only 60% in manufacturing over the same period. Because of this price effect, while manufacturing production has continued to increase, manufacturing products have become relatively cheaper and less profitable (OECD, 2007f). In contrast, many parts of the services sector have experienced slower productivity growth and prices tend to go up more strongly over time. OECD's manufacturing regions have thus been under pressure to find productivity gains by shaving margins and costs in order to remain competitive.

As the share of manufacturing in regional output and employment has decreased, the importance of the service sector has, in turn, increased. The increases in service employment are as striking as the declines in manufacturing employment. Over the period 2001-2005, US states created an average of 125 000 net jobs in service activities (only the industrial mid-west states of Michigan, Ohio and Illinois had service sector growth that did not outstrip manufacturing job losses). Each Australian state and Canadian province saw service employment grow by an average of 122 000 jobs over the same period. The average OECD region saw an increase of around 25 000 jobs in the "real estate, renting and business activities" sector. The increase in this one service sector category alone offsets average job losses in the entire manufacturing sector.

A number of reasons have been put forward to explain the rapid expansion of service activities. First, the low profitability of manufacturing sectors and the growth of demand for services have tended to push expansion of markets for services, particularly in the most advanced OECD economies. Second, socio-economic and lifestyle factors, including the increased labour productivity of manufacturing, have promoted rapid growth in service industries such as health and personal care, leisure and tourism (OECD, 2007f). Finally, liberalisation and deregulation of markets have opened up new possibilities for business and financial services to expand, both with respect to new services and products in home markets and the ability to expand internationally in certain service activities. This is a general phenomenon visible across all OECD regions.

While there has been employment growth across most service activities (the exceptions include public administration in some regions), data for European regions suggests that most regions are becoming more oriented towards knowledge-intensive service activities. Many capital and core metropolitan regions in Europe already have very high rates of knowledge-intensive service employment. Stockholm, London, Brussels-capital, Helsinki, Berlin and the Île-de-France (Paris) all have rates of employment in knowledge-intensive services that approach or exceed 50%. Furthermore, Eurostat data indicates that most EU regions have seen the share of this category of employment increase dramatically over the past five years. Several regions in Greece, Portugal, Spain and Italy, for example, have seen the share of knowledge intensive service employment increase by more than 25% since 2000.

... with strong variations across regions and across sectors

Looking across OECD regions, it is clear that the decline in manufacturing is 1) far from universal and 2) is influenced by the nature of the industry. In other words, behind the bleak aggregates, there is a great deal of variation across regions.

Despite general trends, manufacturing remains a key employer in a large number of OECD regions. As Figure 1.1 indicates, there is significant variation across countries and across regions in the share of manufacturing in total employment. The highest national levels of manufacturing (at 20% of total employment or above) are found in the Czech Republic, Germany, Italy, Hungary, Japan and the Slovak Republic, Within countries, there are very large variations: for example, Austria (Vorarlberg, 25.8%; Vienna, 10.5%), Portugal (Norte, 27%; Algarve, 5.1%), United Kingdom (West Midlands, 20.0%; London, 8.6%) (see Table 1.A1). Not surprisingly, the regions with the highest starting rates of manufacturing have tended to lose the largest numbers of jobs in manufacturing.

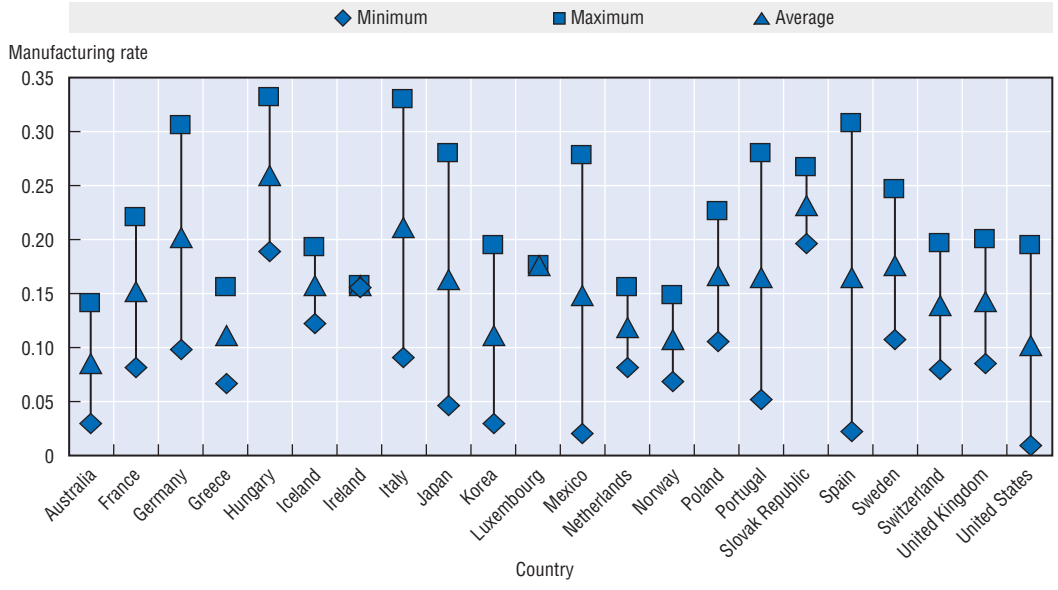
The performance of manufacturing in different regions is strongly influenced by the sectoral or industrial composition of the regional economy.

In certain sectors, particularly textiles, there has been a significant reduction in employment in the OECD area, with relocation of many jobs to non-OECD countries. Over the period 1970-2001, employment in the textile and apparel sectors in OECD countries fell by 6.2 million (around two-thirds of total OECD manufacturing job losses) (Pilat, *et al.*, 2006). There are two main reasons for this. First, labour costs make up a more significant share of total production costs in the textile industry, which makes it more sensitive to wage costs. Second, technological advances have not reduced the labour intensive nature of production enough to make OECD regions competitive production sites. However, innovative firms like Geox (shoes) and Zara (apparel) have shown that production can be profitable without offshoring. In addition, some countries have been more resistant to decline than others. For example, US textile manufacturing declined by 33% between 2001-2003 but in Italy that decline was only around 6% (Berger, *et al.*, 2005).

In some other important industrial sectors such as ICT, pharmaceuticals and automotive, however, aggregate OECD employment levels have been relatively stable or

Figure 1.1. **Share of manufacturing in total employment for regions by country**

2003/4



Note: Regions are at the Territorial Level 2.

Source: OECD (2007e), *OECD Regions at a Glance*, OECD Publications, Paris.

have shown only moderate declines (OECD, 2007f). In each case, the sources of growth or stability, as well as current economic uncertainty, tend to be different. Moreover, behind the aggregate figures, there is often significant job churning and increases and decreases in employment and output across regions within the OECD.

Each of the OECD regions studied (Detroit/south-east Michigan, Turin and the Västra Götaland region) has lost manufacturing employment, both overall and in the auto sector. The main car makers in each of the regions (GM/Ford/Daimler-Chrysler, Fiat and Volvo Cars/Saab, respectively) have gone through major crises and have shed employment. The actual or threatened impact of restructuring of the industry has caused economic upheaval in each region. It is true that the evolution of the sector has been towards lower labour intensity and higher productivity, resulting in a downward trend in terms of employment in the three regions. Nevertheless, there are dimensions of the crises experienced by the these regions that appear more related to market decisions by key firms, over-capacity in the industry, poor financial management and other things that do not necessarily imply a definitive decline. For example, car manufacturing is increasing in other parts of the United States as a counter-example to Detroit/south-east Michigan.

ICT employment maps to the ups and downs of recent industry trends, with sub-sectors growing at different rates. The main identifiable factor with respect to manufacturing employment in the ICT sector is the upheaval caused by the ICT bubble in 1999-2001, provoked initially by the crash of ICT-related stocks on the New York stock exchange, and the subsequent recovery from that. The case studies of Ottawa and Stockholm illustrate the role the performance of a particular industry and the risks that this can entail when the industry contracts. Employment in the ICT industry in Ottawa fell by around 20 000 after the industry slump in 2001. Similar high and sudden job losses happened in the ICT sector in the Stockholm and Eindhoven regions as well. But in each case, output and employment in the industry have rebounded (though more completely in Ottawa than in the other two regions). In each case, the sector-specific shock, more than other identifiable longer-term processes, seems to have triggered a restructuring of the sector in the region.

The biopharmaceuticals industry is one of the few manufacturing sectors to have created employment over the last decade. Other sectors, including ICT and auto, have seen stable employment levels (OECD-wide) over the period, but only pharmaceuticals actually grew (Pilat, *et al*., 2006). Regions with a strong biopharmaceuticals industry have benefited from this expansion. For example, the pharmaceuticals sector in north-western Switzerland (and neighbouring regions in Germany and France) has a sustained record of job growth along with an average GVA growth rate of approximately 10% per year between 1995 and 2004. The pharmaceuticals and biotechnology industries in the two other OECD regions studied – Stockholm and Montreal – also both saw rapid and sustained growth over the past decade.

The coincidence between continuing decline in manufacturing employment, the increase in offshoring and severe slumps in some high-technology industries has given the impression that the future of these sectors in OECD countries is under threat. But the evidence from regions like Montreal, Eindhoven, Ottawa, the Basel region and Stockholm is that OECD regions can still achieve export growth and create employment in manufacturing (and/or in service activities related to manufacturing). Given such industry-specific variations in the performance of manufacturing in OECD countries, the challenge

for regional policy makers is to understand the drivers of structural changes. The policy response needs to differentiate between temporary, sector-specific downturns and firm-level restructuring *versus* more permanent changes in the fundamentals that determine the competitiveness of the region in those industries.

... and growth in related high-value services

The transition that regions have experienced is not only related to changing levels of employment but also to the type of employment.

First, a significant number of manufacturing industry jobs are actually in service occupations. In other words, in some industries, the production facilities have relocated but a range of related service jobs – usually high-value functions – remain. Yet these jobs are still classified as manufacturing sector jobs. OECD estimates suggest that on average around 40% of workers employed in manufacturing sectors are actually employed in service occupations (Pilat, *et al.*, 2006). Examples of these occupations include computer and network services, finance, business, sales, marketing, and legal professions, among others. As one would expect, the rates are particularly high for countries with strong high-tech manufacturing sectors such as the United Kingdom, the Netherlands, Sweden and Finland.

Second, the service value added component of many manufactured goods has increased, whether the service is provided in-house or outsourced. This means that manufactured goods often have an increasingly high service value added embodied in the final product. This is clear from the auto industry, where computer software and ICT supports are an increasingly important part of the car design. This is also true in the ICT sector where much of the growth in mobile technology is based around applications software, such as multimedia where media giants like Disney are working with ICT companies to adapt their production to mobile ICT supports.

This transition away from manufacturing production activities is clear in most of the case study regions. In most cases, the regions combine either specialised or high-skill manufacturing with related knowledge-intensive services. They were once high volume production sites but are now more diverse mixtures of manufacturing and service activities, often with blurred lines between the two and close interlinkages. The extent of the shift varies according to the three sectors studied, with ICT being the least production oriented and the automotive industry remaining more production oriented.

Regions engaged in ICT related industries have seen a shift from production of telecom equipment to telecom service activities. For example, the Ericsson-driven ICT cluster in Stockholm was engaged until recently in telephone handset production, employing around 20 000 production employees. Over the past decade, virtually all production activities have moved overseas. Nevertheless, employment in the sector has remained more or less constant because of the expansion of telecom network and systems support services, which are now a major part of Ericsson's market. There has been a similar evolution in Ottawa's ICT industry. At first, the industry depended heavily on Nortel and grew as that company expanded its telephone and semiconductor production businesses. However, as Nortel restructured, the sector has evolved and broadened. The ICT crisis of 2000 brought significant job losses, but the sector rebounded on the back of a large number of small ICT firms specialising in software applications and advanced ICT service activities.

There are, however, examples of regions that are still strong in niche manufacturing in ICT related activities. In Eindhoven, the ICT industry (Philips, ASML, NXP, FEI) is still internationally competitive in advanced, high-value manufacturing. The industry grew out of Philips, which has been a technology developer for more than 100 years (starting with lighting, then television, radio, data processing, storage and transmission of images, sound and data). Today, NXP (the spin-out of Philips' semiconductor division since September 2006) is the second largest manufacturer of semiconductors in Europe and the cluster has developed strengths in materials and embedded systems. In other words, the industry in Eindhoven is innovating in high-tech equipment and materials rather than moving into network, software applications or systems support, as was the case with Ottawa and Stockholm.

The case study regions specialised in biopharmaceuticals (Montreal, north-western Switzerland, Shanghai and Stockholm) have all witnessed a shift towards higher-value manufacturing and services. Overall, the most basic drug production processes have relocated, but more complex production related processes are still competitive in OECD locations. In north-western Switzerland, the number of employees in the chemical and pharmaceutical industry declined while the more specialised, less production oriented life science branch created employment between 1995 and 2004 (approximately 7%) over the same period, which indicates a shift towards tertiary sector activities. Both Pfizer and Astra Zeneca have announced layoffs among the personnel involved in manufacturing in the Stockholm region while reinforcing investment in upstream non-manufacturing processes.

The automotive industry is a little different because the regions still emphasise car production and the value of maintaining at least some production close to HQ and R&D centres. Although the regions produce fewer cars than in the past, they are still production sites (though within globalised production systems involving numerous other locations). Fiat, for example, has production plants in Italy, Poland, Brazil and Argentina as well as joint ventures and licensing production agreements in a number of other countries including Morocco, Egypt, South Africa, China and India. Nonetheless, production is still concentrated in the Turin region, in close proximity to headquarters and design and R&D centres. The same model is used by most other car makers such as Renault and BMW in Europe and Toyota in Japan.

Manufacturing in OECD regions can still be competitive, but this competitiveness is not as clearly defined around production as it was before. OECD regions are involved in complex and internationalised production systems in which they tend to occupy the high-value functions whether manufacturing or service activities. The ability of regions to produce in industries that are very cost sensitive suggests: 1) that firms in the regions derive certain productivity gains from location within the region, but also 2) that the production system in the region uses network inputs from other places, where those inputs can be produced cheaply. In other words, it would be a misleading to assume that all stages of the production process are internalised within the region.

Specialisation and clustering

A key feature of regional economies is the level of concentration and specialisation that they exhibit. This is not a new phenomenon, of course, as the idea that regions specialise in particular industries where they have a competitive advantage is a basic

principle of economic theory. But it seems paradoxical that in an era when it is possible to produce any good in any location, firms tend to locate in the same places to produce the same or similar goods. There has been renewed policy attention on the issue of the concentration of economic activity because of the assertion that: 1) certain activities, particularly high value added activities, are increasingly concentrated, and 2) this concentration can increase the productivity of firms and make them more innovative. The current debate surrounding the EU's Lisbon Agenda to support a knowledge economy illustrates the link between the achievement of key economic objectives and the issue of specialisation.

Given that regional economies are often closely linked to a limited number of key industries, the performance of those sectors has an important influence on regional performance overall. The declines in employment in textile and clothing industries mentioned above has had serious consequences for many OECD regions because these sectors are among the most geographically concentrated industries (over 40% of employment in each sector in Europe and the US is geographically concentrated). At the same time, the automotive, pharmaceuticals and branches of the ICT industry are also similarly clustered, and the growth of these industries has, in turn, boosted regional economic growth in these places. Anticipating changes in demand by sector is thus a key dimension of the process of economic policy making at regional level.

Countries are increasingly specialised

The concentration of production has an international dimension. A recent OECD report on the evolution of manufacturing noted that some OECD countries have developed or consolidated competitive advantages in specific types of products, categories of technology or particular market segments. With regard to high and medium-high technology sectors, one key message is that manufacturing by sector seems to be increasingly concentrated; with certain countries increasing their specialisation in sectors in which they have a competitive advantage. This trend is true for both countries with existing strengths in those sectors and newer entrants. Only a few OECD countries, notably Switzerland, Ireland, the United States and the United Kingdom have a strong comparative advantage in high-technology manufacturing. Several others, notably Japan and Germany, are particularly strong in medium-high technology industries, such as machinery, electrical equipment and cars (Pilat, *et al.*, 2006).

The report also identifies some significant recent shifts illustrating that countries become relatively more specialised in different types of production. For example Finland and Hungary have become hubs of high-technology manufacturing and the Czech Republic, the Slovak Republic, Korea, Portugal and Turkey have become more competitive in medium-high technology industries. The globalisation of production in ICT goods provides an illustration of these evolutions. Between 1996 and 2004, total OECD ICT goods trade increased by 6.5% a year, while that of Mexico and the eastern European members increased by 17.4% a year (OECD, 2006c).

This sorting on the basis of technology intensity is also apparent in way different countries specialise in different market segments within the same industry. For example, in 2003 Japan had a 16% share of the US market for imported televisions, but only 3% by volume (numbers of TVs imported). The average unit value of imported TVs from Japan was around USD 1 000, whereas the corresponding unit values for Mexico and China were

Table 1.3. **Market shares in value and quantity for TV exports to the United States**

Exporter	Share of market value	Share of market in terms of units exported	Average value of units (USD)	Growth in share, in value terms (1998-2003)
Mexico	48	33	308	2
Japan	16	3	1 034	64
Malaysia	13	20	137	24
China	9	13	96	75
Thailand	7	13	118	11
Korea	3	4	160	29

Source: Japan External Trade Organization (JETRO), ITC calculations/COMTRADE.

USD 300 and less than USD 100 respectively.[2] Moreover, over the period 1998-2003, Japan's export volume increased by 33% and export value by over 60%, indicating that Japanese firms were consolidating their share of the quality end of the US market (see Table 1.3). Another example is provided by the car industry where vehicles produced in the Detroit region source inputs of different types from different countries. For example, engines are largely sourced from Canada, electrical parts and interiors/upholstery from Mexico and chassis from China (Klier, 2007).

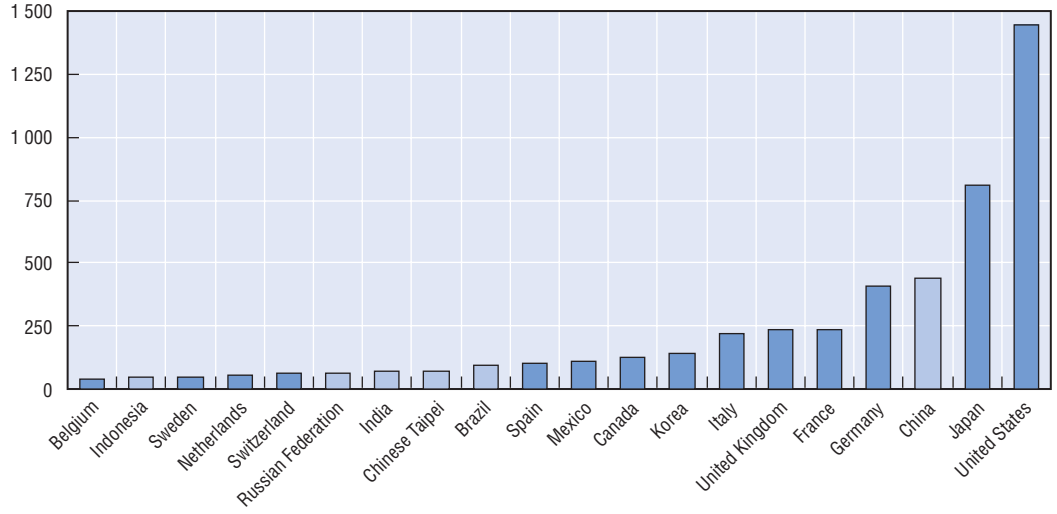
The importance of non-OECD regions in manufacturing has increased. The share of world value added produced in China and in East Asia (excluding China and Japan) has risen from around 2.8% and 1.5% to 6.8% and 7.1% respectively between 1980 and 2000. As a result, the share of manufacturing production accounted for by OECD countries has declined overall, as well as their share of export markets (OECD, 2006c; OECD, 2007f). This can be seen clearly in data on the ICT industry:

- In the late 1990s, 70% of OECD ICT equipment imports came from other OECD countries and 30% from non-OECD countries. By 2004, the OECD share had fallen to 58% and that of non-OECD countries had risen to 42%.
- Between 1996 and 2004, imports of ICT goods into the OECD from non-OECD countries grew by 12%, while imports from OECD countries grew by only 4% respectively.
- China's ICT goods exports grew by 40% a year between 2000 and 2004.
- China (excluding the Hong Kong, China and Macao Special Administrative Regions) is now the world's largest exporter of ICT goods at more than USD 180 billion in 2004, eclipsing the United States (USD 149 billion) and Japan (USD 124 billion) (OECD, 2006c; Ernst, 2006).

However, the main trend is not simply the rise of specific countries as manufacturers of final products competing with those of other countries. After all, despite recent declines in market share, OECD countries still dominate the manufacturing sector with nine out of the top ten global manufacturing countries belonging to the OECD (see Figure 1.2). Rather the key trend is the increasing integration of new countries into global production networks. This trend is exemplified by the increasing share of parts and components in exports, particularly from emerging Asian economies. The overall trends suggest that most Asian economies are becoming more dependent on relationships with OECD-based producers as they become more integrated into production system in which they provide key components for products that are finished elsewhere (see Chapter 2).

Figure 1.2. **Top 20 manufacturing countries, 2002**

USD millions



Note: Data on value added are converted at exchange rates. The estimates should be interpreted with caution.

Source: OECD STAN database, UNIDO and National Statistical Offices in OECD (2007f), "Synthesis report on Global Value Chains" (DSTI/STP/TIP[2007]5).

Regions specialise in different types of goods

Many of the sectors that are most open to global competition are, in reality, heavily concentrated in specific regions. Economic geographers mapping the location of economic activities by region have found clear concentrations across all types of industries. Some of the sectors that have been hardest hit by job losses are also among those that are most concentrated. At the other end of the spectrum, many high growth industries, such as pharmaceuticals, are also strongly regionally based.

The idea that specific places specialise in particular activities and that firms engaged in the same or related activities tend to cluster together have been key observations in economics for a long time. The concept of Ricardian comparative advantage from the early 19th century developed the notion of national and regional specialisation. The theory assumes that differences in endowments such as geographic location, presence of raw materials and cheaper labour generate economies that enable one place to produce in a given industry more competitively than another and thereby to specialise in that activity. A century later, Alfred Marshall's work elaborated the reasons for greater firm productivity when several firms in the same industry are located in proximity to one another, notably labour market pooling, knowledge spillovers and supplier specialisation. Subsequent theories have argued that specialisation in a particular industry brings with it a process of accumulation of assets and advantages (cumulative causation), implying a self-reinforcing nature in this process (Krugman and Venables, 1990).[3]

Looking across countries, the differences in the level and nature of specialisation at the regional level are very clear. Each of the countries have regions – core or capital regions – that have very low rates of specialisation in manufacturing overall but above average (and in some the highest) rates of specialisation in high-technology manufacturing. Alongside this, there are some other regions that concentrate strengths in both high-technology and low- and medium-technology manufacturing (such as Catalonia and the Basque Country in Spain, Lombardy and Piedmont in Italy, Alsace and Rhone-Alpes in France). Then, there are

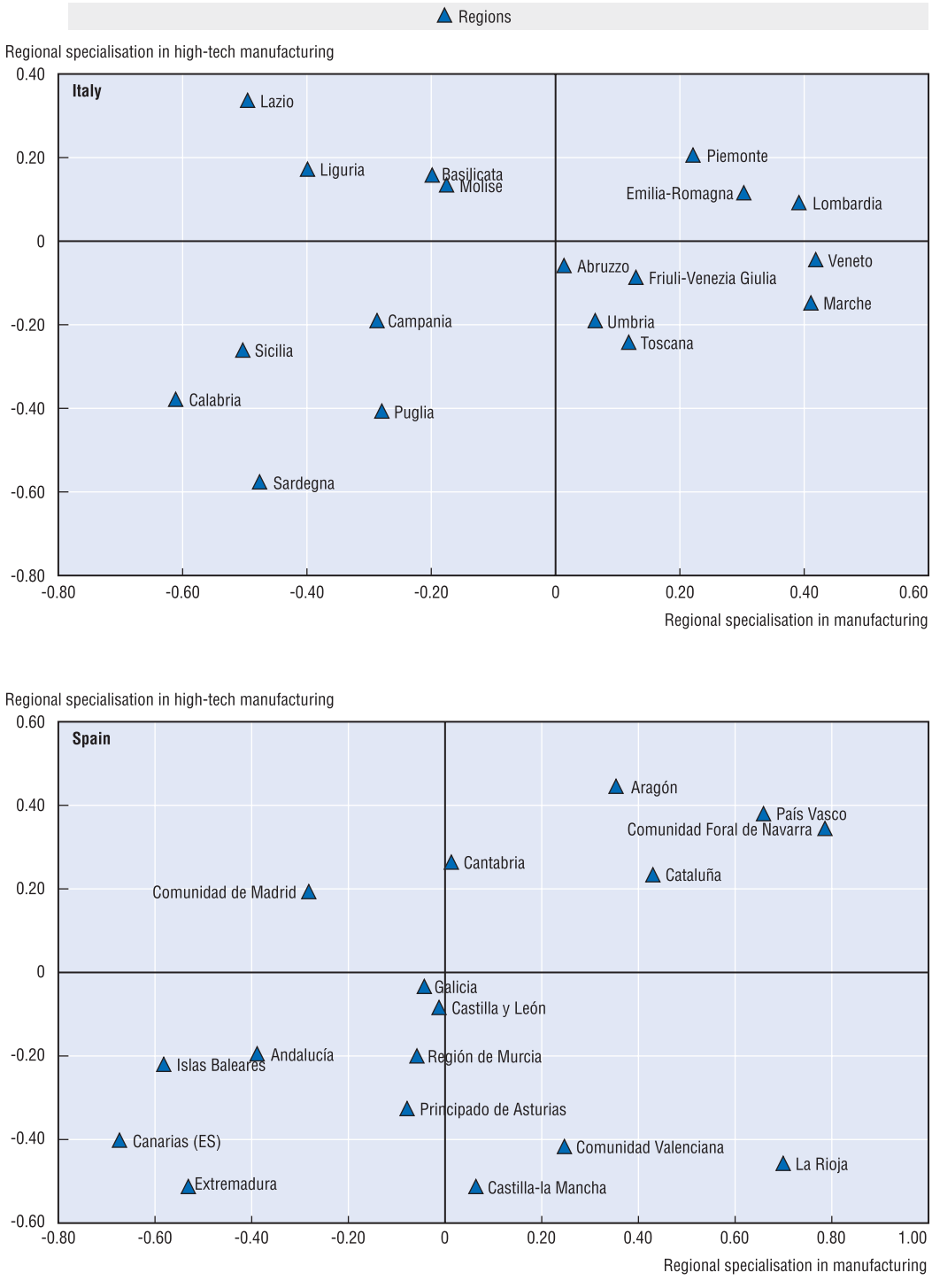
a larger number of regions that are strong manufacturing but have below average rates of specialisation in high-technology industries (see Figure 1.3).

Figure 1.3. **Regional specialisation by technology intensity: France, Czech Republic, Italy and Spain, 2003/4**

The national averages for each index are set to zero (0=1); a positive value indicates above average specialisation, a negative value below average specialisation.

Figure 1.3. **Regional specialisation by technology intensity: France, Czech Republic, Italy and Spain, 2003/4** *(cont.)*

The national averages for each index are set to zero (0=1); a positive value indicates above average specialisation, a negative value below average specialisation.



One striking pattern in terms of regional specialisation is that high-technology manufacturing is often concentrated in regions that have very low shares of

manufacturing activity. In other words, regions can have strong high-tech manufacturing but little manufacturing of other types. The examples of Vienna, Île-de-France, Prague, Lisbon, Bratislava, Berlin, London and Stockholm are striking (Table 1.4). The inverse is also common; regions can have significant manufacturing employment – well above the national average – yet employment shares in high-technology manufacturing that are equally far below the national average.

Evidence from patent statistics tends to confirm the central importance of specialisation in OECD economies. Overall, patents are concentrated in a small number of regions within countries. On average, 57% of total patents recorded in OECD member countries in 2003 came from only 10% of their regions, up from 54% in 2001. A comparison of the indexes of geographic concentration for patents and for population with tertiary education shows that in most countries patenting is significantly more concentrated than the highly skilled population (OECD, 2007e). This suggests that other factors than simply workforce skills are involve, notably the presence of technical infrastructure and the presence of patent intensive industries. In both cases, these tend to be very strongly concentrated within OECD countries.

With respect to the expected link between innovation outcomes and the productivity of firms, the correlation between patent applications and labour productivity within regions during 1998-2003 is positive in 19 out of 22 OECD countries (only in Belgium and Greece is the correlation negative and statistically significant). The positive correlation was

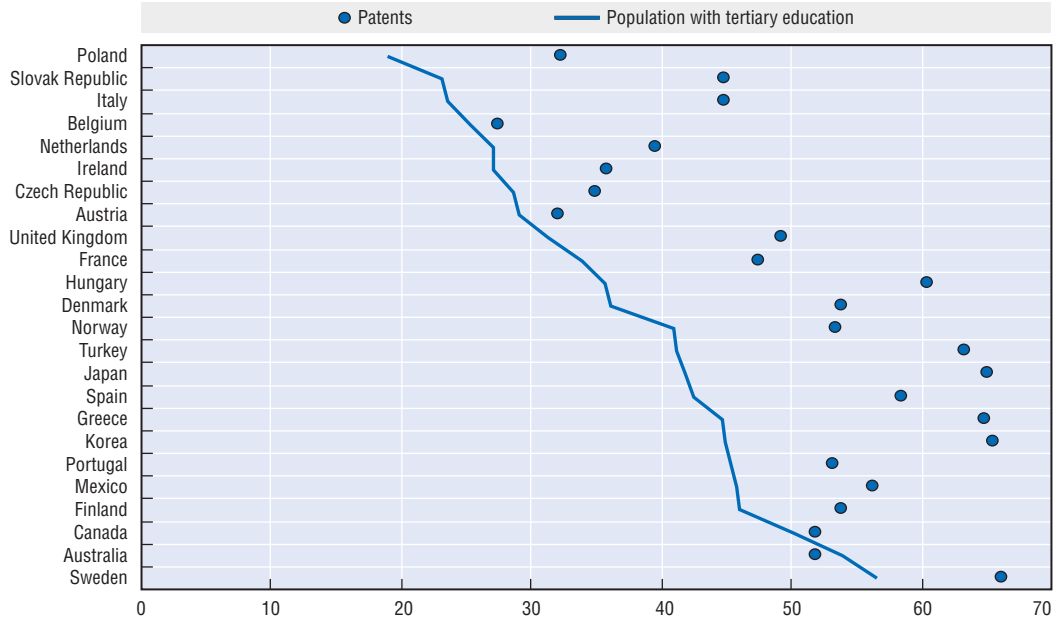
Table 1.4. **Contrast between specialisation in manufacturing and in high-tech manufacturing for selected EU regions**

Country	Region name	Index of specialisation in manufacturing (2003 or most recent year)	Index of specialisation in high-tech manufacturing (2004)
Austria	Vienna	0.62	1.10
Belgium	Région de Bruxelles-Capitale/Brussels Hoofdstedelijk Gewest	0.75	1.03
Czech Republic	Prague	0.43	1.19
Finland	Itä-Suomi	0.88	0.70
France	Languedoc-Roussillon	0.59	0.70
	Île-de-France (Paris region)	0.74	1.38
Germany	Berlin	0.46	1.05
Greece	Nisia Aigaiou, Kriti	0.50	0.58
Hungary	Közép-Magyarország	0.80	1.04
Ireland	Southern and Eastern	0.99	1.02
Italy	Calabria	0.39	0.62
Luxembourg	Luxembourg (Grand-Duché)		1.00
Netherlands	West-Nederland	0.75	0.91
Norway	Oslo og Akershus	0.60	0.92
Poland	Lubelskie	0.58	0.93
Portugal	Lisbon	0.64	1.95
Slovak Republic	Bratislava	0.82	1.22
Spain	Canarias	0.33	0.59
	Madrid	0.72	1.18
Sweden	Stockholm	0.65	1.12
Switzerland	Ticino	0.54	0.91
United Kingdom	London	0.60	0.98
	South East	0.77	1.20

Note: The national average is 1.0 for each index; a value above 1.0 indicates above average specialisation and vice versa. Regions shown are those with the **lowest** specialisation in overall manufacturing.

Source: Based on Eurostat data.

Figure 1.4. **Concentration index of patenting activity and population with tertiary education**

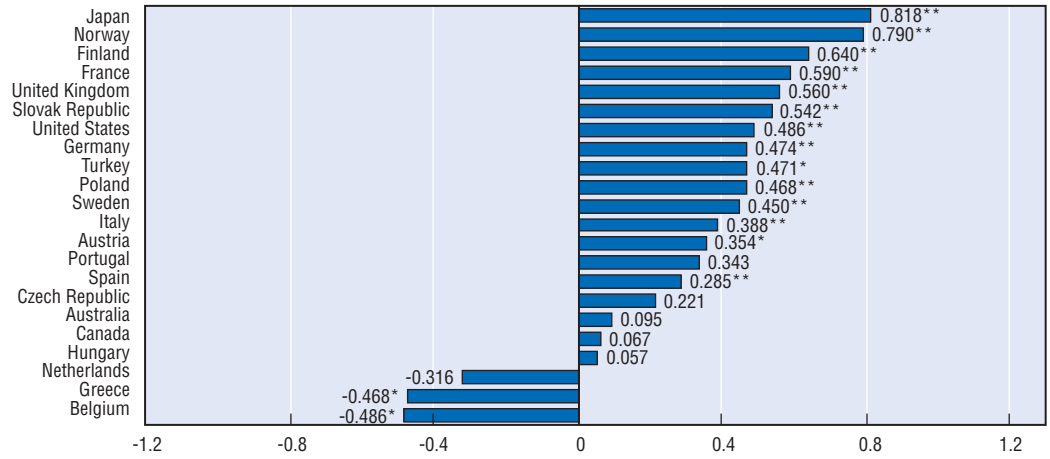


Source: OECD (2007e), *OECD Regions at a Glance*, OECD Publications, Paris.

particularly pronounced in Japan (0.82), Norway (0.79) and Finland (0.64), followed by France (0.59), the United Kingdom (0.56), the Slovak Republic (0.54), the United States (0.49), Germany, Turkey and Poland (0.47), and Sweden (0.45). In all these countries the relationship was statistically significant (OECD, 2007e).

The concentration of innovation-related assets is also striking. The ten leading regions in Europe in terms of GDP per capita account for more than one-third of all patents. At the same time, while these ten regions were responsible for more than 250 patent applications

Figure 1.5. **Spearman rank correlation of regional labour productivity and regional patent applications, 1998-2003 (TL2)**



* Indicates significant at 95%.
** Indicates significant at 99%.

Source: OECD (2007e), *OECD Regions at a Glance*, OECD Publications, Paris.

per million each across all high-technology sectors, one-third of EU regions recorded less than one patent per million in the same year. Moreover, there is a very strong link between certain characteristics of regional economies and innovation. For example, the level of patenting activity is strongly correlated with GDP per capita (correlation coefficient of 0.86, significant at the 0.05 level), with students in higher education (correlation coefficient, 0.81) and with employment in high-technology industries (correlation coefficient, 0.85).

Regions also specialise within technology fields. The Noord Brabant region around Eindhoven (one of the case study regions) generates more than 10% of European semiconductor patents (see Table 1.5). Stockholm performs strongly with respect to patents in both life sciences/genetics and ICT equipment (see Table 1.6). While most of the regions are large urban regions, the influence of major research centres and the clustered high-tech activities around them is visible. For example, the strong patent performance of the UK region of East Anglia is largely attributable to the technology cluster around Cambridge University.

Similar concentrations of high-technology activities can be seen in the United States as well. As shown in Figure 1.6, there is a general relationship between high-technology firms and states with higher GDP per capita, as would probably be expected. Other data pertaining more directly to innovation suggest a stronger concentration of high-technology capacity. Patent data, for example, shows the large differences between innovation hubs such as San José, Boston, Rochester, Raleigh-Durham and even Detroit and the large

Table 1.5. **Patent applications in semiconductors**

Patent applications per million inhabitants

	2000 (1990)
Oberpfalz, Germany	48 (0)
Oberbayern, Germany	47 (12)
Dresden, Germany	46
Noord-Brabant, Netherlands	**45 (14)**
Bayern, Germany	25
Kärnten, Austria	20
Sachsen, Germany	18
Mittelfranken, Germany	16
Prov. Vlaams Brabant, Belgium	12

Source: Based on Eurostat data.

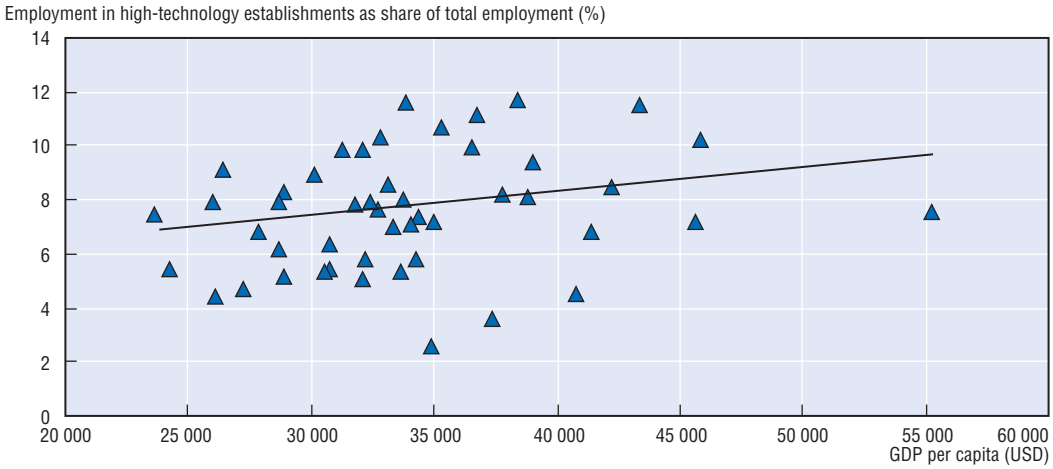
Table 1.6. **Patent applications in ICT**

Patent applications per million inhabitants

	2000 (1990)
Noord-Brabant, Netherlands	**552 (124)**
Stockholm, Sweden	**327 (42)**
Etelä-Suomi, Finland	233
Pohjois-Suomi, Finland	212
Oberbayern, Germany	370 (129)
Manner-Suomi, Finland	185 (23)
Länsi-Suomi, Finland	166
East Anglia, United Kingdom	196 (70)
Sydsverige, Sweden	180 (11)

Source: Based on Eurostat data.

Figure 1.6. **Employment in high-technology firms and GDP in US states (2002, 2003)**



Source: National Science Foundation database.

majority of other US metro regions (Hunt, 2007). One interesting indicator is the level of venture capital disbursed (per USD 1 000 of gross state product). The average for all states is around USD 1 of venture capital for every USD 1 000 of state product. When Massachusetts (USD 8.70) and California (USD 5.73) are excluded from that figure, the average drops considerably to only around USD 0.65 of venture capital. The large ratio between the amounts of venture capital available in states like California and Massachusetts as compared to the majority of other states reflects the technology intensity of the two states economies. National Science Foundation data shows a strong correlation between the level of venture capital in the economy and the technology intensity of the regional economy (measured as the proportion of total employment in high-technology firms). The relationship between state-level GDP and employment in high-technology firms is also positive.

Employment in high-value services is also strongly concentrated. The share of high-technology services in total employment for most EU regions rarely surpasses 4% (the average for all regions is around 3%). These activities appear to be concentrated mainly in parts of Belgium (Brussels and Western Flanders), the Netherlands (4-6%), Sweden (more than 8% in Stockholm), and the United Kingdom (notably parts of the South-East and Eastern regions with rates of between 5-10%). Combining these activities, total high technology employment (high- and medium-technology manufacturing plus knowledge intensive services) can represent a significant share of employment in some regions – over 20% in a few German *Länder*, over 15% in Piedmont and Lombardy in Italy, over 10% in Catalonia and the Basque Country in Spain and similar shares in the South and Midlands regions of the United Kingdom.

The level of technological specialisation influences the place of the region in production systems and the type of products that it produces. Car production plants for top of the range models tend to be located close to research and design centres in traditional production centres (Germany, Italy, France and the United States, plus the United Kingdom for sports and luxury models) while small cars are produced in more diverse locations (sites in Portugal, Slovak Republic, Turkey, Mexico and in Asian non-OECD countries).

Table 1.7. **Theoretical benefits of clusters**

Concept	Benefit
Marshallian externalities	
Labour market pooling	Labour cost savings due to access to specialised skills, especially in an environment where quick turnaround is important
Greater variety of specialised intermediate goods and services	Access to a local supplier base that has more product variety and a high degree of specialisation
(Tacit) knowledge spillovers	Access to tacit knowledge in geographic proximity by means of both formal processes as well as through such informal channels as knowledge leakages made possible by casual inter-firm interactions
Porter's market conditions	
Demanding customers	Motivational effects due to demands of highly competitive local customers that improve quality, cost, etc.
Rivalry	Motivational effects related to social/peer pressure
Complementarities	Better sales opportunities of firms due to search cost savings for the buyers of complementary products offered in proximity and privileged opportunities for co-operation (sales, marketing, etc.) between nearby suppliers of complementary products
Cost advantages	
Transportation	Transportation cost savings due to geographic proximity, especially in the case of just in time delivery contracts
Trust	Transaction cost savings due to an environment that encourages trust

Source: Adapted from Lublinski, A. (2003), "Does Geographic Proximity Matter? Evidence from Clustered and Non-clustered Aeronautic Firms in Germany", *Regional Studies*, Vol. 37, pp. 453-467.

Table 1.8. **Characteristics of science-based and traditional clusters**

	Science-based	Traditional
Age	Young industries, new concentrations	Mature industries, established concentrations
Type of relationships/transaction	Market-based, temporary coalitions for R&D joint ventures	Long-term relationships, market based local supply chains
Innovation activity	Technological innovation	Incremental innovation, technology absorption

Source: Adapted from EC, Enterprise Directorate-General (2002), *Regional Clusters in Europe: Observatory of European SMEs*, N. 3/2002, European Commission, Brussels.

Moreover, parts and components for cars also tend to be sourced from regions according to their level of technological specialisation – the highest value components for US car productions come from Canada, then Mexico, and the lowest value parts come from Asia.

Regional clusters and knowledge spillovers

Region-level specialisation, which is clear in a large number of industries, raises the related issue of clustering. The term regional cluster refers to geographically bounded concentrations of *interdependent* firms (Rosenfeld, 1997; OECD, 2001), and tends to cover concepts like industrial districts, specialised industrial agglomerations and local production systems (OECD, 2007a). The cluster concept is seen as one explanation for the persistence of specialisation at the regional level despite the increased range of options for firms to relocate production away from higher cost locations. In other words, firms concentrate together, thereby increasing the level of specialisation of a region, because they benefit from clustering effects generated by this geographical proximity to one another. The benefits of clustering are usually presented as including the following elements.

One useful distinction is between the more science-based clusters and the more traditional industry clusters. This is clearly visible in different sectors. The different

histories of the clusters and the recent evolutions of production methods in different sectors lead to the generation of quite different types of external economies for firms located in the region. For example, transactions in traditional clusters are based primarily on long-term relationships between customer and supplier and they emphasise incremental innovation (process or product innovation) while for newer science-based clusters these relationships may have a much shorter time horizon and be more focused on new technology development

In order to understand the different ways that regional economies are clustered, typologies have been developed that generally distinguish between two main categories: 1) "Marshallian" clusters comprised primarily of locally owned SMEs (in both lower and high technology activities), and 2) "hub and spoke" clusters or "industrial-complexes" dominated by one or several large firms surrounded by dense supplier networks. These typologies also include instances of concentration without real cluster behaviour among firms in regions where, for example, the hub is a branch plant that has little interaction with local firms or where firms are grouped around a public facility such as a military base (OECD, 2007a).

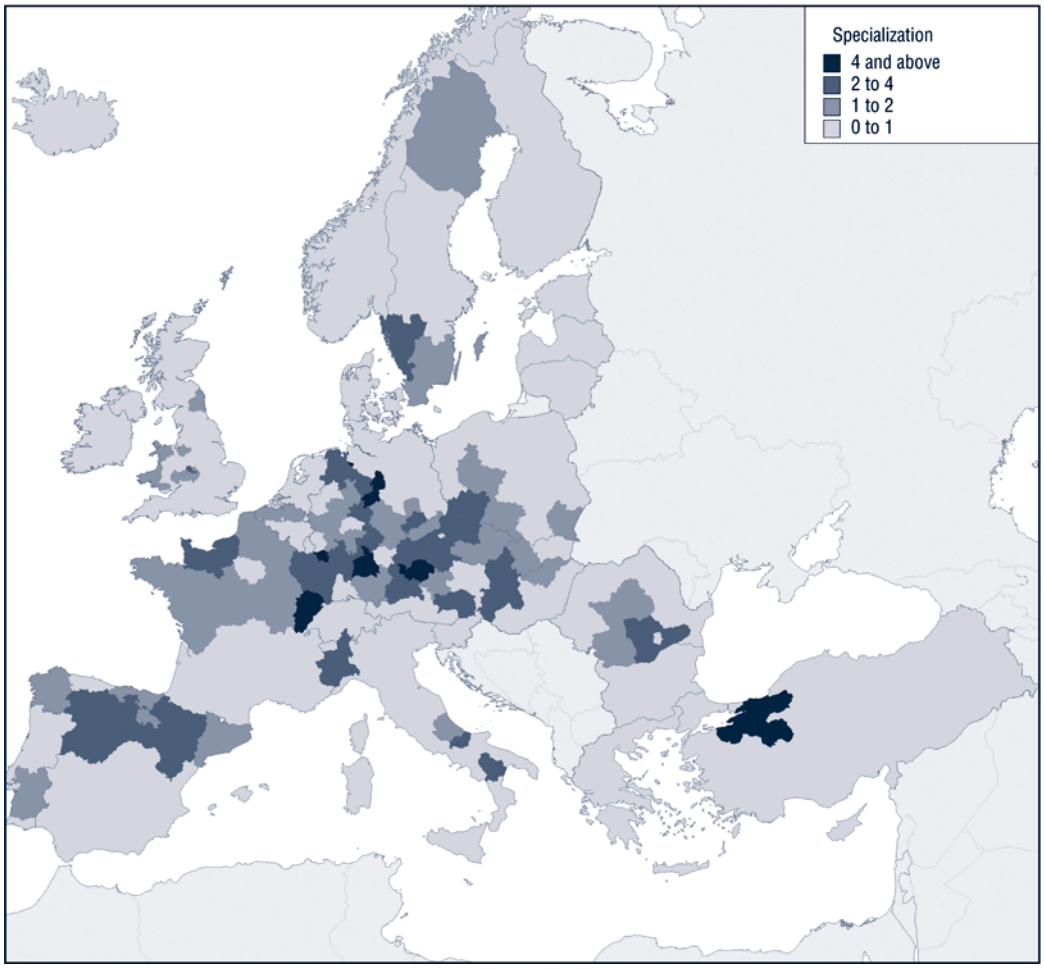
The different sectors studied here exhibit characteristics of both the two main cluster categories (ICT and biotechnology more Marshallian and automotive and pharmaceuticals more the hub and spoke variety).

The automobile industry is one industry that is clustered in a limited number of regions, mainly in established industrial sites with strong "traditional" cluster characteristics. For example, the success of the European automotive industry (car, bus and truck assembly, engines and other components) is built on a network of about 25 regional clusters that account for more than half of all European employment in the industry (see Figure 1.7). There are few automotive clusters of lesser intensity, indicating that regions either have a strong position in automotive or are hardly present at all.

The three automotive regions studied are characterised by classic hub-and-spoke vertically integrated industry structures, with one or a few large firms linking a broad, local supplier chain. For example, in the Västra Götaland region, the auto cluster has several leading vehicle manufacturers that are nodes in the global network. The major vehicle manufactures (AB Volvo, Volvo Car Corporation and Saab Automobile) and their suppliers (such as SKF, Autoliv, Haldex and Opcon) constitute the motor of the industry. Automotive R&D, conducted by these companies through universities and research institutes, plays a significant role in the development of Sweden's automotive sector. Beyond these major firms, the industry is structured around approximately 200 SMEs that act as suppliers of components and services. The pattern in Turin is similar, with most of Fiat's major suppliers being located in the province of Turin (around 75% of modules and systems suppliers) and employing around 70 000 people in addition to those employed by Fiat. The system of clustering in Detroit/south-east Michigan is similar but on a massive scale.

The nature of these traditional clusters is changing. Given the economic centrality of the sector and the widespread automotive culture, the automotive sector is still regarded as a key sector in each of the three regions. As such, the notion of the auto cluster is still strong, not only with respect to employment or economic importance but in terms of developing, testing and applying new technologies. The new focus varies across the regions, but the emphasis is increasingly on the global positioning of the regions as centres of excellence in design and

Figure 1.7. **Specialisation in the automotive industry in the EU area**



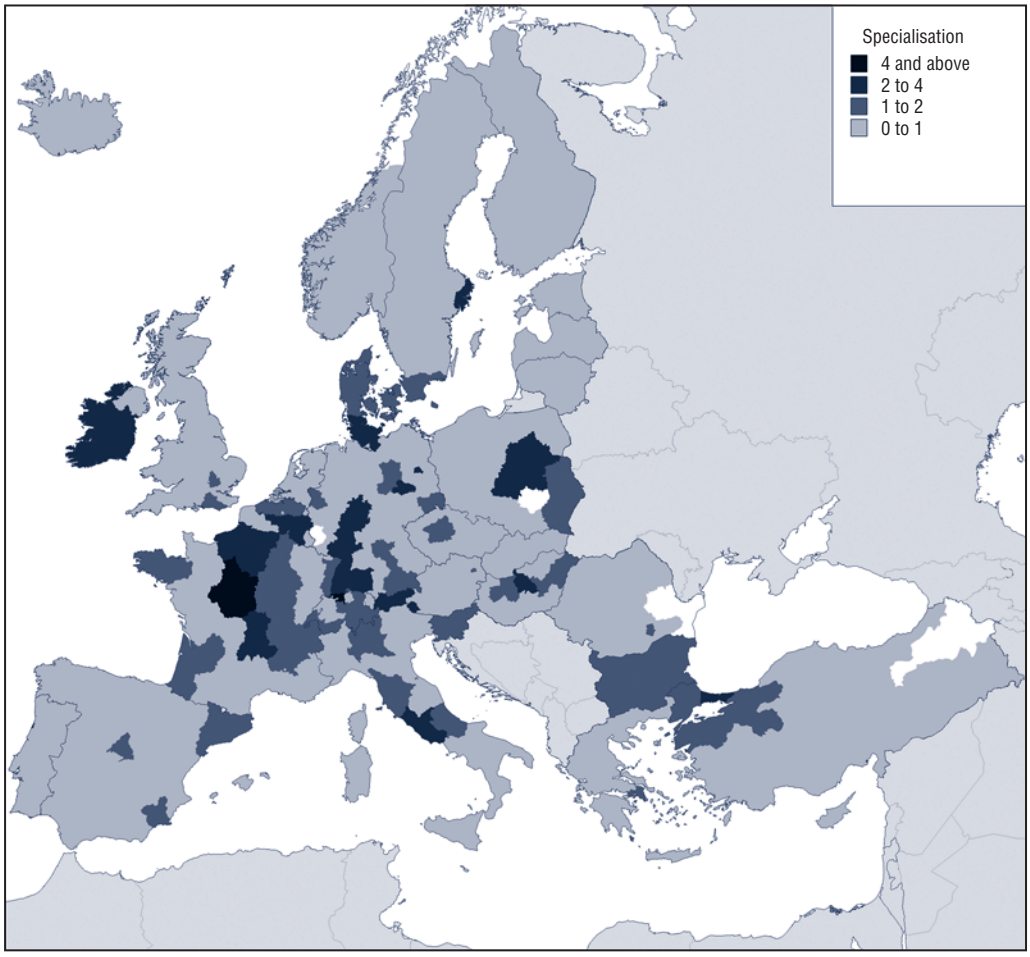
Source: European Cluster Observatory, ISC/CSC cluster codes 1.0, dataset 20070512.

innovation in global automotive markets (or more broadly technology markets), not exclusively or primarily linked to Fiat, Ford or any of the other traditional regional champions.

The pharmaceuticals industry is also strongly concentrated in particular regions, with clusters usually growing out of regional specialisation in the chemicals industry (see Figure 1.8). Other factors such as the momentum provided by national health care systems or public R&D investment strategies have also played a role. Stockholm, for example, has a long tradition of life science research with effective collaboration between researchers at the universities, industry, the government and the health care sector. The Swedish pharmaceutical and medical device industry emerged as a result of this and generated a number of globally competitive innovations such as the pacemaker, gastric ulcer drugs, diagnostic allergy tests and equipment for protein separation. Two major pharmaceuticals companies, Astra and Pharmacia, started in the region and have driven the emergence of a concentration of pharmaceuticals and biotechnology companies.

By contrast, the ICT industry is less concentrated and clusters are less traditional in structure. ICT clusters tend to see more rapid evolutions in relationships among firms and

Figure 1.8. **Specialisation in pharmaceuticals in the EU area**

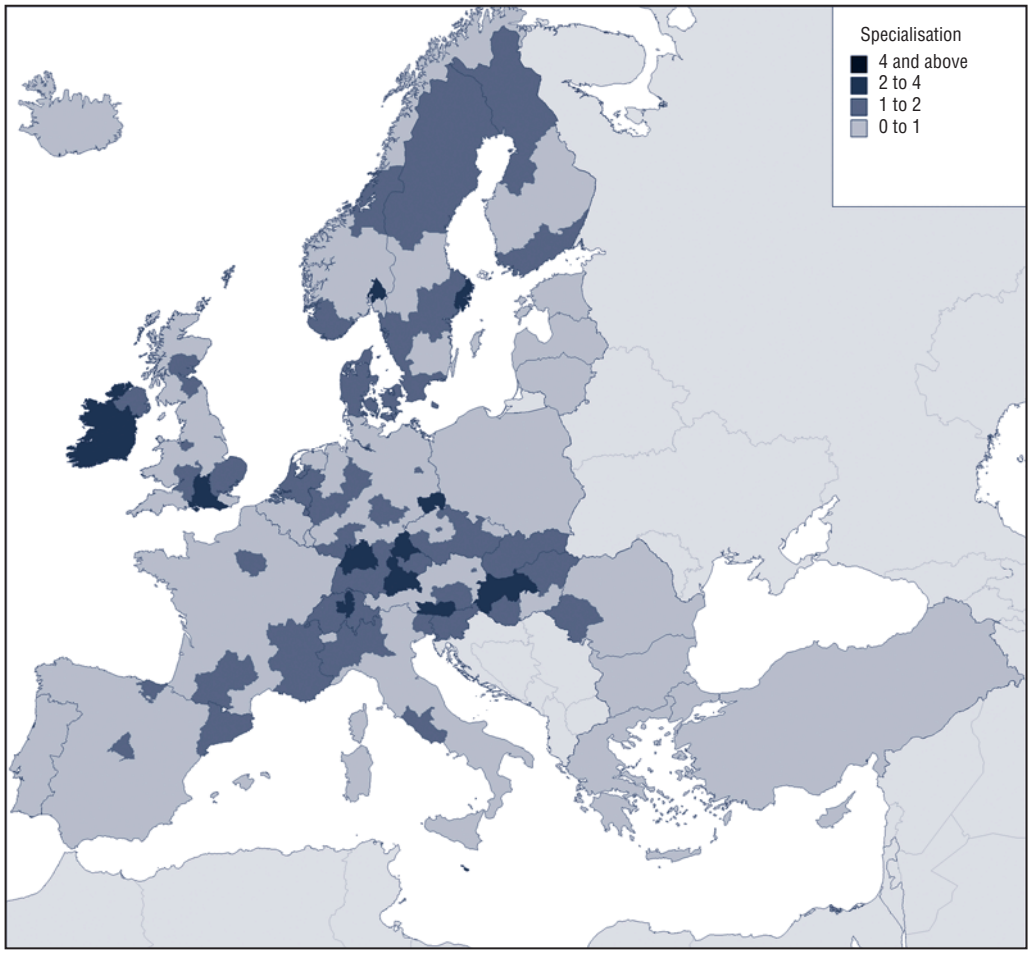


Source: European Cluster Observatory, ISC/CSC cluster codes 1.0, dataset 20070512.

supplier chains are internationalised (see Figure 1.9). ICT is generally a far more diffuse industry classification with a large number of branches and sub-branches encompassing a wide range of both manufacturing and service occupations. The industry is not always as diffuse, however. At the sub-sector level, there is significant regional concentration. Looking at Mexico, the ICT equipment industry is almost exclusively in small pockets in the border regions (see Figure 1.10).

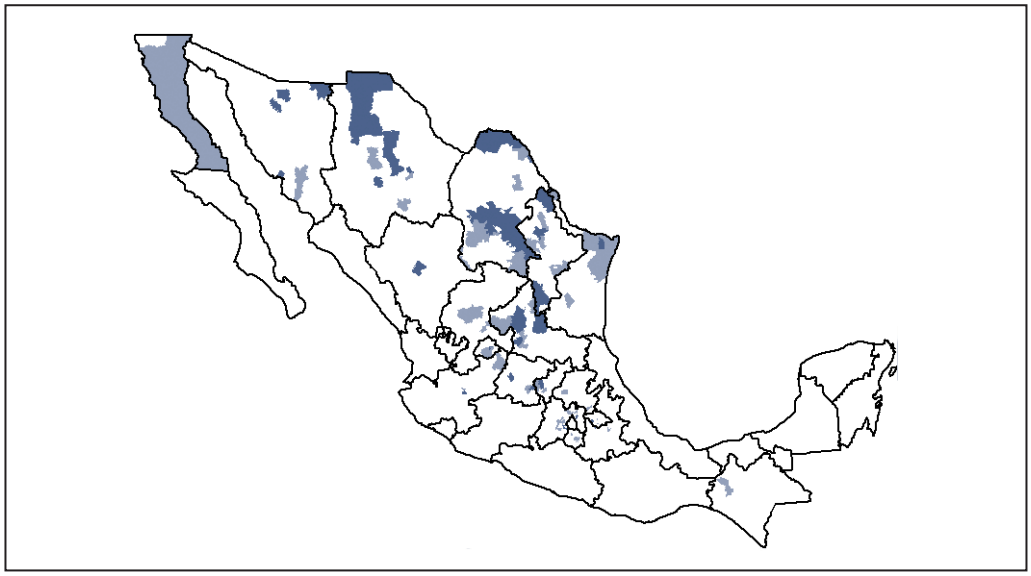
Among regions involved in ICT industries, there is evidence of clustering among firms but the firm structures and relationships seem to evolve more rapidly, with less clear hierarchies among firms. Stockholm's ICT sector, although spread across the region, has a concentration of key large and small firms in the Kista area, where Ericsson moved its headquarters, followed by Adobe, ABB, HP, Intel, Nokia, Oracle and Sun. These firms are all looking to tap into typical cluster advantages such as a qualified labour market, access to specialised services, etc. However, the ICT clusters studied tend to be more dynamic than those in auto or biopharmaceuticals and the focus of the leading firms is more prone to rapid evolution. In general, ICT industries cover a broad range of sub-sectors some of which expand rapidly, while others stagnate as new technologies or standards replace old

Figure 1.9. **Specialisation in ICT industries in the EU area**



Source: European Cluster Observatory, ISC/CSC cluster codes 1.0, dataset 20070512.

Figure 1.10. **Concentration of ICT equipment in Mexico**



Note: Shaded areas indicate a location quotient greater than four.

technologies. This is the case with Ottawa, for example, with several sub-specialisations appearing over the past few years – mobile communications (large, expanding), software applications (transforming, new technology driven) and photonics (small, high growth). Both Eindhoven and Ottawa are good examples of formerly vertically integrated systems that have gradually become more horizontal and entrepreneurial.

One motivation for interest in clusters is the accumulation of evidence from different countries that both productivity and wage levels can be higher in clustered activities than in non-clustered activities (see Box 1.1). Furthermore, that clusters in "traded" (as opposed to local or resource dependent) industries have a strong influence on the overall prosperity of the region and on its average wage level. Porter found that clusters increase the contribution of traded sectors to regional output and wages (Porter, 2003). Similar research by METI in Japan and the Bank of Italy has suggested a correlation between clustering and higher productivity.

Another more recent motivation is the link made between clusters and innovation. Research into the sources of productivity advantage in clusters focuses principally on the positive impact of the circulation of people and knowledge around a local economic system. These knowledge flows in turn support the generation of innovative ideas and the development of new products and technologies. Within dynamic high-technology clusters, levels of personal exchanges between firms appear to be higher than in non-clustered locations. This type of "cross-pollination" of ideas and innovation is put forward as one of the main drivers of the success of the Silicon Valley model (Saxenian, 1994).

Although cluster mapping tends to suggest that there is a less clear link between clustering and innovation performance in European regions overall, empirical research seems to verify the thesis for some regions. For example, the successful Stockholm ICT cluster exhibits higher rates of inter-firm labour mobility that the rest of the labour market and higher rates of intra-firm mobility than other comparable private-sector enterprises (Power and Lundmark, 2004). Work by Cooke (2004) on the biosciences industry in Sweden also reveals a close association between proximity and knowledge transfer. The value of both the biopharmaceuticals and ICT sectors to the regional economy can be seen both in terms of employment and wage level (See Table 1.9).

Nevertheless, there are risks related to the use of a cluster approach generally, as well as with more specific risks relating to the design of these programmes. Insufficient economic

Box 1.1. **Innovation performance in the EU and US: evidence from cluster mapping**

The idea that clusters are a key driver of innovation is currently being tested at the international level via a Europe-wide cluster mapping exercise. The first results from this review suggest significant differences between Europe and the US in terms of the level of concentration and specialisation at the regional level. The average US region tends to be more specialised and to have stronger concentrations in terms of employment by a factor of one-quarter – 28% of employment in the average US region is in a strong cluster, while in Europe only 21% of the region's employment is clustered. The initiative aims to assess to what extent the relative strength of US regions compared to EU regions can be said to influence the level of innovation and the extent to which poorer outcomes in terms of R&D performance in Europe can be attributed to the structure of firms and their relationships at the regional level rather than to the level of investment inputs or other factors.

Source: European Cluster Observatory, *www.clusterobservatory.eu*.

Table 1.9. **Regional specialisation in the Stockholm-Mälar Region, 2003**

Industry	Employment	Wage/per worker (SEK 1 000)	Employees with higher education (%)
ICT	77 627	406	35.6
Biotech/pharmaceuticals	26 424	363	35.7
Rest of privately owned companies and public sector	989 872	247	21.3

Source: The County Administrative Boards in the Stockholm-Mälar Region.

diversification, lock-in (in the sense of being tied by long-term investment strategies to supporting specific sectors and being unable subsequently to change track) or over-reliance on key firms are among the dangers that are associated with the cluster approach. Other concerns relate to how effective the public sector can be in identifying instruments that can help firms to react to very rapid changes in global markets and production systems.

Regional specialisation and clustering in non-OECD countries

While developing countries integrate into global production networks, there is also evidence that regions are specialising and that new clusters are developing. The emerging patterns of spatial location of the automotive industry provide some illustrations of clustering in non-OECD countries. The key to competitive production in the auto industry is minimising the carrying cost associated with large inventories, by means of tighter production planning, precisely scheduled delivery of components and drastic reduction of component failures, which otherwise could slow down production runs. As such, many of the benefits of clustering are also being sought by producers in non-OECD countries. An important point to note is that clustering in certain non-OECD countries comes about due to inadequate infrastructure, as is shown by the example of Maruti in India (Box 1.2). It may also be due to public policies promoting special zones to attract FDI or co-locate firms, such as with the automotive industry in Shanghai. OECD MNEs are increasingly able to find

Box 1.2. **Clustering driven by Maruti in India**

Lack of road infrastructure and vast distances between production centres and markets have forced supplier firms to cluster around assembler firms. The resulting ecosystem of supplier firms has shown remarkable efficiency in delivery schedules and quality control, thereby improving the overall quality of the end product. As a result, both foreign and domestic manufacturers have pushed for the progressive localisation of component suppliers.

For example, in the mid-1990s the main challenge for India's leading car manufacturer, Maruti, was inventory costs. From 1992-1997, inventory carrying costs were up to 4% of sales revenue (in comparison labour costs amounted to only 2%-3%). The average in-transit inventory costs were particularly high. For the Maruti management the remedy lay in localising the supplier base to the maximum extent possible. By 1997, Maruti had managed to cluster 70% of its components and materials within a radius of 80 km, and inventory costs had converged with labour costs. In 2001, about half of its top 100 domestic suppliers, accounting for roughly 50% of the purchase value, were located near the assembler.

Source: Gulyani, Sumila (2001), "Effects of Poor Transportation on Lean Production and Industrial Clustering: Evidence from the Indian Auto Industry", *World Development*, Vol. 29 No. 7, pp. 1157-1177.

reliable production partners in non-OECD countries that make investment a less risky operation. Renault's investment in Nashik in partnership with Mahindra and Mahindra is a good example of this. Renault is able to develop a low cost, high operating margin production process by joining forces with an established local manufacturer with strong supplier networks and a skilled workforce (Sen, 2007). Here the MNE is reinforcing regional specialisation. Mercedes-Benz and Skoda, as well as domestic manufacturers, are also located in the region.

The biopharmaceuticals industry is also strongly concentrated in particular regions in non-OECD countries. The main criteria seem to be a critical mass of scientists and research infrastructure, the existence of venture capital and, in some cases, the presence of a domestic industrial base in a related industry (*e.g.*, chemicals). Venture capital appears to be particularly important. In India, for example, more than 75% of venture capital has been placed in only five states (Maharashtra, Tamil Nadu, Andhra Pradesh, Gujarat and Karnataka), leading to strong growth of capital intensive industries in those regions (Bowonder and Mani, 2002). From the perspective of this report, the development of the biotech industry in Bangalore and Hyderabad is interesting because it has been supported by the existence of ICT skills and specialised firms. These assets have helped the biotech industry develop a specialisation in bioinformatics in those regions, while in the other biotech clusters in India are based around chemicals or drug manufacturing centres.

While Shanghai, one of the case study regions, is a diverse manufacturing centre and an international financial hub, its economy is based around "pillar industries" that account for the majority of its gross regional product (GRP). These pillar industries include microelectronics, automotive, chemicals, high quality steel and shipbuilding. However, its economic base is broadening to include identifiable clusters in ICT, biotechnology, pharmaceuticals, and financial services. These industries tend to be strongly concentrated, partly as a result of the government's policy of developing special zones and parks.

The life science sector in Shanghai is an important and growing sector, even if still comparatively small. The industry is dominated by foreign companies that have offshored segments of their R&D and production to China. For example, the region has over 140 foreign-controlled R&D laboratories. The predominant part of the sector is located in the Zhin Yang science park in Pudong. The park was established some 15 years ago to focus on high technology, particularly in two areas: ICT and pharmaceuticals. There are over 55 000 total employees in the park. Over the last six to seven years, a number of institutions and research institutes as well as foreign big pharmaceuticals companies have located to the area (for example, Roche, Novartis, GE Healthcare, Boehringer Ingelheim, GlaxoSmithKline, plus related companies such as Du Pont and Estée Lauder). Furthermore, the government is promoting links between public agencies, research institutions, foreign companies and the 200 domestic start-ups in the park.

Recife in Brazil illustrates another dimension of growth in non-OECD countries, a model that is local asset-driven with only a limited FDI catalyst. Recife is the largest city in Brazil's relatively poor north-east region and the third largest city in the country. The history of the ICT sector in Recife dates back to the beginning of the 1980s, with close collaboration on the development of ICT-based financial services between the university, local software companies and the north-east region's major bank, *Banco do Nordeste*. The positive outcome of the collaboration encouraged the team of professors at the university to promote ICT education in the region. In 2000, the state government launched the cluster initiative Porto Digital to further

develop the ICT sector and facilities were built up in the old harbour and dockland area, housing about 250 start-up firms across a broad business range including computer games, financial services, healthcare systems, logistic in mining and railway, road traffic informatics and software development in general. The reputation of the ICT industry in Recife is now strong and around half of the sector's output in Recife is sold outside the region, mainly to the southern part of the country and in collaboration with MNEs such as IBM, Motorola and Nokia.

Notes

1. For all regional statistics cited in this section from the OECD Regional Database, regions are taken at the Territorial Level 2.
2. The source of this data is the Japan External Trade Organization (JETRO) using ISIC classification 8538 Television receivers including monitors and video projectors.
3. These basic models have been further elaborated by academic fields such as business economics and economic geography. For example, theories on firm performance emphasise the innovative process, notably the quality of factor inputs such as education, the positive rivalry between firms that drives innovation, and the structures/institutions that support innovation (Porter, 1990). Economic geographers, particularly those favouring the flexible specialisation model, have emphasised the importance of non-tradable inputs to production, notably the intangible transaction cost savings that come from networking and co-operative linkages that are embedded locally (Krugman and Venables, 1990). Other schools include regional science (impact of industrial organisation on culture), urbanism (cities have diversity to drive innovation) and economic development (supporting local small firms) among others (Cortright, 2006).

ANNEX 1.A1

Table 1.A1. **Comparison of rates of manufacturing employment in regions, by country (2003/4)**

Country	Region with the highest rate of manufacturing employment	Type	Rate	Region with the lowest rate of manufacturing employment	Type	Rate	Average all regions
Australia (2004)	Victoria	PU	14.0	Northern Territory and Australian Capital Territory	PR PU	2.9	9.5
Austria	Vorarlberg	IN	25.8	Vienna	PU	10.5	17.2
Belgium	Vlaams gewest	PU	17.3	Region Bruxelles-capital	PU	11.5	13.6
Canada	Ontario	IN	17.6	Saskatchewan	PR	5.7	11.0
Czech Republic	Stredni morava	IN	36.2	Prague	PU	12.1	27.8
Denmark (2004)	Vest for storebaelt	PR	19.3	Hovedstadsregionen	PU	9.4	14.4
Finland	Lansi-suomi	PR	23.7	Aland	PR	9.4	16.9
France	Franche-Comté	PR	22.1	Corse	PR	8.2	16.1
Germany	Baden-Wuerttemberg	PU	30.5	Berlin	PU	9.9	19.0
Greece	Attiki	PU	15.6	Nisia aigaiou, Kriti	PR	6.6	11.8
Hungary	Nyugat-dunantul/western Transdanubia	IN	33.1	Kosep-magyarorszag	PU	18.9	24.7
Iceland (2004)	Other regions	PR	19.3	Capital region	IN	12.2	15.7
Ireland	Border, Midlands and Western	PR	15.8	Southern and Eastern	IN	15.5	15.7
Italy	Veneto	PU	33.0	Calabria	IN	9.1	21.0
Japan (2004)	Toukai	PU	28.0	Okinawa	PU	4.6	14.8
Korea (2004)	Gyeongnam region	IN	19.4	Jeju	IN	2.9	12.3
Luxembourg	Luxembourg	IN	17.6				17.6
Mexico (2004)	Chihuahua	PR	27.7	Quintana roo	IN	2.1	9.8
Netherlands	Zuid-Nederland	PU	15.6	West-Nederland	PU	8.2	11.9
New Zealand							
Norway (2004)	Sør-østlandet	PR	14.8	Oslo og akershus	PU	6.8	11.6
Poland	Wielkopolskie	PR	22.6	Lubelskie	PR	10.6	17.9
Portugal	Norte	IN	27.9	Algarve	IN	5.1	14.0
Slovak Republic	Zapadne slovensko	IN	26.7	Bratislav kraj	PU	19.7	23.3
Spain	Navarra	IN	30.7	Ciudad autónoma de Melilla	PU	2.2	16.2
Sweden	Smaaland med oearna	PR	24.6	Stockholm	PU	10.7	16.7
Switzerland (2000)	Ostschweiz	IN	19.7	Ticino	IN	7.9	14.1
Turkey			. .			..	..
United Kingdom (2001)	West Midlands	PU	20.0	London	PU	8.6	15.1
United States (2004)	Indiana	PR	19.4	District of Columbia	PU	1.0	10.3

Note: Region type: PU = Predominantly Urban; PR = Predominantly Rural; IN = Intermediate.

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Globalisation and Regional Economies:
Can OECD Regions Complete in Global Industries?

PART I

Chapter 2

Globalisation and the Spatial Reorganisation of Production

The drivers of change in regional economic structures are assumed to be linked to globalisation, notably the reorganisation of production. This chapter outlines the main drivers of globalisation and explores the role of multinational firms in this process and what this has meant for particular regions. It then reviews the changing geography of production and processes such as outsourcing and offshoring from the perspective of their impact on regions.

Introduction and key points

The processes of change in regional economies are often attributed to globalisation, usually in terms of the threats posed by opening of markets, and, less frequently, with respect to the opportunities that globalisation offers. This research supports other OECD work that indicates that deindustrialisation for most regions and in most sectors is more closely linked to productivity gains from technological advances and industry-level restructuring than to competition from low-wage economies as such. The recent crises that have hit industrial regions examined in this report seem to have more to do with sector-specific shocks, such as the crash in ICT-related stock values in 2000-01 or the slump in sport utility vehicle (SUV) sales in the US market, than to more direct drivers of globalisation.

Nonetheless, the reorganisation of production is having a major impact on the way firms think about how they organise production and where they locate different segments of the production process. Classic cost equations still matter, but the assessments made by large firms are increasingly complex and evolve very quickly. Moreover, the competition to retain and attract investment now involves not only traditional OECD regions but a wide range of newer entrants in OECD and non-OECD countries.

Key points

- Globalisation's main drivers – such as liberalisation and improvements in transport and communications – have had some direct impacts on spatial location of economic activities. For example, trade agreements can radically alter the location of production within countries.
- MNEs have been major beneficiaries of globalisation, which has allowed them to access new markets. In many regions the expansion of MNEs over the latter part of the 20th century created large numbers of jobs, helping to ground regional competitive advantages through the growth of supplier chains, specialised skills, etc.
- More recently, restructuring of MNEs – consolidation, M&As and break up of large firms – has had a major impact on regions. Changes in ownership of large firms, through mergers and other operations, have tended to reduce the embeddedness of firms in their "home" region, which has consequences for the stability of the regional enterprise base. At the same time, downsizing of these MNEs has released entrepreneurial talent that has contributed to dynamic start-up firms in some cases.
- Offshoring (defined as the outsourcing of activities abroad) is an issue, but does not appear as central as the restructuring of large firms or sector-specific shocks (such as in ICT) or even market shifts (such as the SUV sales slump and its impact on the Big 3 car makers).
- Outsourcing (defined as the production of inputs outside of the firm) appears to be broadening the structure of regional economies by changing the relationships among firms within the region. However, the reshaping of these relationships is often difficult and many supplier firms are under severe pressure.

- While internationalisation of R&D is well advanced, this has usually concerned OECD countries (investment by US firms in research facilities in the UK or in Sweden for example). Now, large firms are increasingly offshoring research to lower cost locations, potentially undermining the competitive advantage enjoyed thus far by OECD regions in knowledge generation.
- Innovation offshoring could pose a major challenge. For the moment, R&D in China and India by foreign firms focuses on very specific segments, but there are examples where full range R&D and product development is undertaken in these countries by MNEs.

Globalisation drivers and their spatial impacts

Although the term globalisation can have several meanings, from an economic perspective it refers to the increasing cross-border integration of production and markets for goods, services and capital. Globalisation has three main components: 1) increased trade in goods and services; 2) increased capital and labour flows; and 3) transfers of production facilities and/or technology. This process leads both to a widening of the extent and form of international transactions, and to a deepening of the interdependence between the actions of economic actors located in one country and those located in other countries (see for instance Narula and Dunning, 1998; OECD, 2006b; Ernst, 2006). These exchanges have increased in intensity and complexity over the past decade and are linking places that were hitherto remote from each other. The clearest (interrelated) evolutions in the world economy, include:

- New approaches to the organisation of production, notably fragmentation of production systems facilitated by ICT;
- The increasing dominance of multinational enterprises and the development of complex production networks involving large numbers of firms;
- A decoupling of product development and manufacturing, with product development undertaken often by firms that have no manufacturing assets; and
- A dramatic increase in the efficiency of ICT systems that co-ordinate these activities across long distance at high speed.

More open and accessible markets

The liberalisation process that has shaped globalisation over past decades has opened a range of opportunities for firms to reorganise the way goods are produced. Liberalisation of national utility and network service markets, for example, have made it possible for foreign firms to enter domestic markets that were previously protected. At the same time, newly privatised domestic firms have been freer to take advantage of new opportunities arising abroad. This trend has been reinforced by the liberalisation of international movements of capital and the more welcoming policies for FDI adopted in a growing number of countries.[1]

Market liberalisation can have important direct spatial impacts. Changes in trade patterns have resulted in significant region-level changes in demand for labour and the nature of skills as well as reorientations in investment flows. The impact of regional agreements such as the EU or NAFTA on the spatial location of production among members is a good example. When most Mexican firms produced for the domestic market, using local inputs, it was logical for them to be located close to both the suppliers and the consumers; *i.e.*, in or around Mexico City. Post-NAFTA, given that the United States is the

main market and source of most inputs, manufacturing and new investment concentrated near the US-Mexican border, rapidly changing the economic geography of Mexico and influencing that of the United States (OECD, 2004a).

Liberalisation therefore provides firms with a number of clear advantages that were less exploitable in the past. First, they now have a greater range of choices for market entry, be it via trade, licensing, subcontracting or franchising (*locational specialisation*). Second, they enjoy better access to external resources and capabilities that they may need to complement their core competencies (*outsourcing*). Third, there are far fewer constraints on the geographic dispersion of the value chain (*spatial mobility*). The ability of firms to exploit these advantages, aided by the improvements in communications, has transformed the value chain architecture upon which enterprises rely. These changes lead to an increasingly sophisticated fragmentation of production, the formation of new international alliances, and the creation of increasingly complex and extensive international supply chains.

Faster and cheaper communications

The reorganisation of production depends crucially on the speed and cost of the service links, both physical and electronic, that knit the components of production networks together (Jones and Kierzkowski, 2005). Advances in ICT have brought about drastic improvements in the ability to store, manipulate and distribute information. As a result, it has become cheaper and easier to manage distant and widely dispersed production networks.[2] Table 2.1 shows the dramatic fall in the price of telecommunications, with current prices below one-third of 1992 prices. Rapid developments in these technologies have increased tradability particularly in service sectors that were up to now only tradable to a limited degree and that in many regions now constitute an important source of employment.

The impact that ICT-enabled offshoring is likely to have on OECD labour markets has been the subject of intense discussion. What is clear is that the emergence of this form of offshoring has shifted the globalisation debate away from its limited focus on certain manufacturing sectors or manufacturing processes that concerned specific regions or region-types towards a more general concern about economy-wide impacts. Over the last couple of years this has led to concerns about a more generalised process of offshoring (the so-called "second wave") which would affect broader segments of OECD economies than the previous wave of offshoring which mainly involved relocation of labour-intensive manufacturing.

Advances in transport have also contributed significantly to the ability of firms to reorganise their production systems. A look at the growth of container ship transport capacity illustrates how this technology is driving the globalisation process. While the

Table 2.1. **The reduction in leased telephone line pricing (1992-2004)**

	Year			
2 Mbit/s line length	1992	1996	2000	2004
2 km	100	112	62	48
50 km	100	83	46	32
200 km	100	82	48	31

Source: OECD (2006), *OECD Information Technology Outlook*, OECD Publications, Paris.

merchant fleet has grown, the size of ships has also increased. Already container ships can reach more than 300 metres and can handle more than 9 000 containers. In the future, they could carry enough containers to fill a line of trucks 68 miles long (*The Economist*, 18 March 2006). In parallel, container handling technologies have reduced port turnaround times from three weeks for a bulk cargo ship to 24 hours for a container ship, leading to large reductions in inventory and storage costs for firms. Given that inventory and storage costs are often cited as reasons why supplier networks should be localised, the proven ability of firms to manage dispersed, transport-dependent production networks suggests that this argument in favour of clustering is now less relevant.

The declining fixed costs involved in different types of transportation are a major factor alongside labour costs and other input costs in determining where production will be located. The continuing evolution of these costs can rapidly change the location decision equation. Comparison of the relative competitive advantages of China and Mexico shows that transport and proximity advantages with respect to US markets still give Mexican exporters a significant cost and time advantage, but these can be more than offset in some sectors by labour cost differentials combined with falling transport costs (Table 2.2). Although the underlying explanations are not certain, China's share of US imports increased from around 8% in 1999 to near 14% in 2004. Over the same period, around one-fifth of *maquiladora* enterprises moved out of Mexico (OECD, 2005).

Table 2.2. **Comparison of average factor costs for Chinese and Mexican exports to the US**

	Mexico	China
Hourly wage in manufacturing (USD)	2.13	0.66
Hourly wage in clothing industry (USD)	2.45	0.88/0.68
Total cost of shipping a 40 foot container to the US (USD)	1 750	4 300
Average number of days in transit	2	12-18

Source: OECD (2005), *Economic Survey, Mexico*, OECD Publications, Paris.

The globalisation of firms and implications for regions

Multinational firms: their role in linking regional and global economies

Multinational firms have become the main actors of the globalisation process. While often MNEs are considered as a result of globalisation processes, they should also be seen as drivers in their own right. By 2004, the number of MNEs had risen to some 70 000 with at least 690 000 foreign affiliates, almost half of which are now located in developing countries. Between them, MNEs are responsible for two-thirds of global trade and 80% of investment (UNCTAD, 2005b). As the role of MNEs in the world economy has continued to grow, the decisions that these firms take has also become a more important factor driving further liberalisation. Hence, they are today more than ever an economic force behind globalisation.

The share of foreign affiliates in manufacturing output can be significant. American multinationals in manufacturing, for example, earn half of their turnover abroad and half of their employees are located abroad. Foreign-controlled high-tech employment now represents 40% of high-tech manufacturing employment in France and more than 50% of high-tech manufacturing turnover. For many OECD countries the share of intra-firm exports of affiliates under foreign control is also a large percentage of total national

exports. For example, in 2001, 31% of Swedish exports were intra-firm exports by non-Swedish MNEs, up dramatically from only 11% five years earlier in 1996. The comparable figure in 2001 was 37% for the auto industry and 19% for the pharmaceuticals industry (OECD, 2006e).

The increasing interlinking of national economies via MNEs has been given added momentum by the wave of mergers and acquisitions (M&A) and other forms of industry consolidation. In the 1980s and 1990s, a business model based on cross-border consolidation of production emerged, facilitated by opening of markets and relaxing of regulations governing international transactions. Many manufacturing and more recently service industries went through a major round of consolidation under which larger corporate entities were created. This consolidation was designed not only to provide market access and take advantage of trade liberalisation, but also to reduce costs in response to falling market demand and falling prices. The changes included rationalisation in all aspects of the business, from R&D and manufacturing to purchasing and back-office functions such as finance, logistics and advertising. This process resulted in fewer but larger companies, able to manufacture and sell globally.

In many cases, this consolidation process totally reshaped industries that had been relatively stable elements and major employers in regional economies for many years. The structure of the pharmaceuticals industry, for example, had changed little for most of the latter part of the 20th century. However, in the late 1980s the industry started a dramatic series of waves of international merger activity, creating new multi-country conglomerates. The first wave, in the late 1980s and early 1990s, saw the emergence of Bristol-Myers Squibb and Smith-Kline Beecham. The second wave started in 1994 when American Home Products merged with Ayers and Wyeth, followed a year later by the creation of Glaxo Wellcome, Pharmacia and Upjohn, and Hoechst, while in 1996, Novartis was created from Ciba-Geigy and Sandoz. In 2000, Pfizer merged with Warner Lambert and then acquired Pharmacia in 2002. The change in ownership of Pharmacia, for example, has had an important influence on the evolution of the Stockholm-Mälar region's biotechnology industry.

A similar pattern of increasingly large conglomerates was visible in the automotive (see Table 2.3). However, while the pace of mergers reached a peak around 2000, since then

Table 2.3. **The consolidated auto industry**

Group	Owned or linked brands
BMW	BMW, MINI, Rolls-Royce
DaimlerChrysler	Mercedes-Benz, Chrysler, Dodge, Jeep, Smart, Maybach, Freightliner
Fiat	Fiat, Lancia, Alfa Romeo, Ferrari, Maserati
Ford Motor Co.	Ford, Mercury, Lincoln, Volvo, Jaguar, Land Rover, Aston Martin, Mazda
General Motors	Chevrolet, Pontiac, Buick, Cadillac, Saturn, SAAB, Opel, Vauxhall, Holden, Daewoo, Isuzu, Suzuki
Hyundai Motor Co.	Hyundai, Kia, Asia
Renault-Nissan	Renault, Nissan, Infinity, Samsung, Dacia
PSA	Peugeot, Citroen
Toyota	Toyota, Lexus, Hino, Daihatsu
Volkswagen	Volkswagen, Audi, SEAT, Skoda, Bentley, Bugatti
AB Volvo	Volvo, Nissan Diesel, RVI, White-GMC

Source: Wells, Peter and Paul Nieuwenhuis (2006), "Global Outlook for the Automotive Sector: Future Drivers, Trends and Barriers", unpublished report, Centre for Automotive Industry Research and ESRC Centre for Business Relationships, Accountability, Sustainability and Society, Cardiff University.

the number of major consolidations has reduced. Predictions that the global automotive industry at the vehicle manufacturer level would soon be reduced to four or five major constellations or multi-brand groupings, for example, appear to have been premature. The well-documented example of DaimlerChrysler suggests that the strategic prescription of globalisation through merger and acquisition is easier in theory than in practice. Although further consolidation remains an option in the automotive as well as other industries, the changes in global markets for goods and services do not always favour increasingly large scale-economy-based operations. Exceptions to this rule include, for example, oil and newly opened tradable services.

On a regional scale, the impacts of these changes in complex global groupings can be very challenging for policy makers. As illustrated in Box 2.1 with an example from the car industry in the United Kingdom, alliances and consolidations meant the very rapid expansion and contraction of production facilities, with important impacts on employment of both blue collar and white collar employees on different continents.

Rapid and global-scale restructuring has given rise to some unexpected or undesirable features that regions have to cope with. From the perspective of regional policy makers, there are two particularly troublesome observations. First, the actual facilities get scant chance to enjoy a period of long-run stability during which key activities such as management, investment, training, etc., can be embedded in the region. Second, facilities and plants can become "victims" of change almost regardless of actual performance; they are simply in the wrong place at the wrong time. As will be discussed in the next chapter, evidence from the regions suggests that the nature of the operations carried out by large firms in a particular location (R&D, high-value production, routine assembly, etc.) determines whether or not they become embedded in a particular region and whether or not they profit from locally generated external economies (for example, whether they draw on spillovers from research carried out locally, etc.).

Box 2.1. **The complexity of organising production: a UK story**

1. BMW buys Rover and starts to plan a large facility to make engines at Hams Hall (United Kingdom), with an installed capacity of 400 000 units per annum to meet both BMW and Rover engine needs.
2. Honda, which had been supplying engines to Rover then of course sees sales of engines to Rover decline, and has surplus capacity at its plant.
3. BMW then splits from Rover, thereby losing all the potential revenue having invested in the development of new Rover models. BMW retains the Mini brand but the engines for the car have already been sourced via a joint venture with Chrysler in Brazil.
4. When Daimler-Benz merges with Chrysler to form DaimlerChrysler, BMW is suddenly in the position that their corporate rival is supplying a key component for the Mini, which is now a vital part of their product range.
5. Meanwhile, the BMW UK engine plant at Harris Hall has lost the prospect of Rover business and is running at under half capacity and is eventually sold off back to Rover. Rover, in turn, was unable to remake a viable business structure and finally went into liquidation.

Source: Wells, Peter and Paul Nieuwenhuis (2006), "Global Outlook for the Automotive Sector: Future Drivers, Trends and Barriers", unpublished report, Centre for Automotive Industry Research and ESRC Centre for Business Relationships, Accountability, Sustainability and Society, Cardiff University.

Reshaping the geography of production: outsourcing and offshoring

The challenge of fragmented markets

Enterprises working internationally are confronted with a very fragmented market structure. On the one hand, there are high value but low growth and segmented markets for most goods in OECD countries. On the other hand, there are expanding markets for lower-end products (but also luxury goods) in non-OECD countries. This has provoked a flurry of new business models designed to allow multinational firms to adapt to these different markets. Interestingly, in each of the sectors discussed here and in the regions that were studied, this process seems to be opening up opportunities for new entrants, including innovative SMEs.

An important industry response to the slow growth of mature markets has been to try to exploit segmentation in the market. That segmentation requires forms to target specific consumer needs or preferences through tailored, lower volume but higher margin products. This has involved a range of business strategies aimed at capturing market segments by diversifying product lines, shortening product life cycles and emphasising product innovation. Illustrative strategies include:

- *Stretching* – firms extend the brand range and increase the number of different products to capture more specific market segments;
- *Acquisition* – firms purchase an existing brand in order to capture market share;
- *Collapsing* – firms close an existing brand and focus on core products;
- *Revival* – firms revive a moribund brand or product to generate new market niches ("retro" styles, etc.); and
- *Innovation* – firms create a new brand or product line to capture new markets.

These strategies have resulted in an increased turnover of products, including more brands and models as well as shorter life cycles per model, among other results. The automobile industry illustrates the impact that these strategies have had on the products available for consumers. As indicated in the Table 2.4, there has been a huge increase in the number of models, body styles and variants brought to the UK market. Given that overall market volumes have not changed dramatically in the United Kingdom over this period, the table suggests that sales per variant have more than halved over the past decade. Industry specialists assume that the majority of models do not make money and will be cross-subsidised by the high-selling models. Despite the low profitability of many products, having a diverse range of offerings for the market is thought to represent a more stable production portfolio.

Table 2.4. **Variants in the UK car market, 1994-2005**

	Brand names	Models	Body styles	Variants
1995	56	211	309	1 580
2000	57	262	357	1 931
2005	54	323	376	3 155

Source: Wells, Peter and Paul Nieuwenhuis (2006), "Global Outlook for the Automotive Sector: Future Drivers, Trends and Barriers", unpublished report, Centre for Automotive Industry Research and ESRC Centre for Business Relationships, Accountability, Sustainability and Society, Cardiff University.

This need for segmentation has an important influence on the way firms organise production internally and externally. Firms in mature markets need a range of product offerings covering a growing number of segments, sub-segments and niches, unlike firms in developing markets where a limited product line may suffice. There has been a great deal of interest in the concept of flexible specialisation and productive systems that are capable of exploiting economies of scope and reacting quickly to meet changing demand. In the past, the emergence of just-in-time and similar business models based on Japanese tightly managed production systems were seen as a way to move large corporations away from vertical integration towards a more flexible structure without losing their control over the overall process. The global fragmentation of production can be seen as an extension of this ideal across national borders and with the benefit of much improved logistics and communications service links between the production sites.

Sourcing and location decisions: why firms relocate

The reconfiguration of the production system is based on firms making a range of decisions about how they break up production to make it more efficient and responsive. These decisions – on which activities to source outside the firm (and potentially across borders) and which ones to keep inside the firm (but possibly in a foreign affiliate) – are of crucial interest for both national and regional policy makers. The place of an investment decision within the wider sourcing/location strategy of a firm helps to determine the extent to which linkages and externalities develop with local firms, the employment generation potential and the skills upgrading that can be expected to accrue. For example, a pharmaceuticals MNE in Sweden engaged mainly in production noted that they are more or less self-sufficient and have little need to build synergies either with local suppliers or the regional innovation system. In contrast, another firm in the same industry but more involved in drug discovery and development underlined strongly the importance of being closely involved with innovators outside the firm.

Two types of decision need to be made by firms:

- *Sourcing*: which segments of the production in the value chain should be carried out in-house, and which part should be outsourced? Increasingly firms seem to opt to outsource segments of their production.
- *Location*: where should segments of production be located? What parts of the output should be produced (either in-house or by a subcontractor) in the home country *versus* what part should be produced abroad (again, either by the firm or an affiliate or by an independent subcontractor in that country)?

The principal decision on whether to produce internally or outsource has both industrial/technological and financial motivations. The goal may be to reduce inefficiencies that result from disincentives in a large firm (*agency theory*). For example, a firm may seek to enable technical operations to be carried out without incurring the managerial costs involved in setting this up in-house or to access specialised technical services. The decision to outsource is also linked to the costs of doing business with other firms (*transaction cost theory*). Such costs include the cost of necessary asset-specific investments and the risks involved such as contractual incompleteness and search efforts. Therefore, these costs must be compared against the potential savings due to lower production costs (OECD, 2007d). In some cases, even where the cost savings are not clear, firms opt to outsource in order to restructure and focus on core competencies or

move into new fields or to access expertise and technology that the firm has not been able to develop.

Globalisation has increased the use of offshoring (outsourcing abroad as distinct from outsourcing domestically) to produce a lower cost structure for production than is possible within the same country or economic area. Offshoring strategies usually move high-volume production that requires low skills or standard technologies to locations with lower fixed costs. This relocation can be either within the firm through a foreign affiliate or outsourcing to a contractor. The balance to be struck here is between a more reliable supplier source through an affiliate where feasible *versus* a potentially less reliable external contractor, either where the costs of establishing an affiliate are too high or where the process is sufficiently standardised to enable an arm's length approach (see Table 2.5 for some of the key constraints relating to offshoring).

The decisions are firm specific. Some firms are evidently more reluctant to source complex or high-value added activities externally, as these are often considered strategic or sensitive. There are numerous examples where firms in the same sector and even the same branch have very different approaches. Some leading computer and electronic companies outsource all component manufacture, while others (*e.g.*, Sony) tend to keep some component processes and systems software in-house and use these internal components and systems to maintain the uniqueness and quality of their key products. Texas Instruments now produces only components and has sold off its final product arm, while IBM has famously sold off its production businesses and is now focused principally on business support (Berger, *et al.*, 2005). Many car makers still prefer to have R&D close to production because of the need to refine new components through testing over a long period. Volvo, Fiat and the Big 3 in Detroit/south-east Michigan of the case study regions all keep R&D concentrated close to production sites, as do BMW and Renault. In all industries, there is probably a point at which complete disconnection of strategic functions (HQ functions) from R&D and of R&D from production leads to diseconomies, but it is also clear that there are many exceptions to the rule.

Depending on the industry, firms face different constraints in terms of sourcing options. The auto industry, for example, has been forced to adopt new sourcing strategies given the increase in the number of non-mechanical or non-traditional inputs in modern cars, mainly computer and electronic equipment. As a result, the level of outsourcing, including production of high-tech components, has increased dramatically. Pharmaceuticals companies still tend to keep facilities close to biotech hubs so that new ideas can be quickly identified, even if chemical and drug production is offshored. In contrast, the ICT industry seems less stable and as technologies have emerged and reshaped the industry, the geographical locations of production have altered more rapidly than in other sectors with the result that supply chains are very fluid and extended. These and other constraints affect regional clusters in different ways. Some constraints make local enterprise networks less cohesive, while others reinforce the proximity advantages that clusters offer.

The impact of offshore outsourcing on business performance and regional economies is difficult to measure, but has become an important politically charged question (see Table 2.5). Internal or external offshoring of production for high volume or low margin products or brands can be an effective way to free up investment for more capital-intensive

Table 2.5. **Summary of the impacts of offshoring and possible constraints**

Medium-term employment impacts		Factors unfavourable to offshoring
Positive	Negative	
• Growth in consumers' income • Improved competitiveness and productivity in enterprises • Export growth • Control of inflation • Better returns on capital	• Fall in real wages of a certain category of worker • Deterioration in terms of trade • Possible decline in capacity for innovation • Loss of tax revenues • Regional effects	• Inadequate quality of goods and services supplied • Failure to meet delivery times • Higher costs than anticipated • Failure to respect intellectual property • Technological change • Management difficulties

Source: OECD (2007d), "Offshoring and Employment: Trends and Policy Implications" (DSTI/EAS/IND[2007]2).

investments in the home country. For example, according to the French *Direction des relations économiques extérieures* (DREE), the ten industrial sectors that invested most abroad between 1997 and 2000 (relocation and direct investment taken together) created more than 100 000 new jobs during the same period (an argument used to answer criticism of the negative impacts of delocalisation). When extended to regions, the argument is that the relocation of low-value production with associated job losses frees up labour for more productive activities. Estimations of the positive impact of offshoring vary, but a commonly cited McKinsey report puts the figure at USD 1.44 of value for each USD 1.00 offshored from the US economy (McKinsey Global Institute, 2005). A study by the French CEPII found that for EUR 1.00 invested abroad by a French firm, EUR 0.59 of exports are generated in comparison to only EUR 0.24 of imports.

The fall in manufacturing employment in many OECD countries and regions has often been blamed on offshore outsourcing and relocation of production by domestic and foreign-owned companies. As was mentioned earlier, evidence from OECD work on manufacturing (Pilat, *et al.*, 2006; OECD, 2007d) and from the case study regions converges on the point that the decline in manufacturing output in most sectors is due in very large part to productivity growth, rather than to the displacement of domestic workers through outsourcing or relocation strategies.[3] Nonetheless, even if the actual economic impact of delocalisation of enterprises is limited or even negligible at the national level, delocalisation of enterprises often has a devastating impact on the regions concerned. As such, there is strong pressure on the central government to take steps to prevent delocalisations and to limit their negative effects on regional economies.

Offshoring for market proximity: it is no longer simply a matter of production cost

While relocation of production to lower cost countries has tended to be for production cost reasons, proximity to emerging markets is now an increasingly important motivation.

The growth of manufacturing in Asia has been driven by integration into production networks, rather than by direct competition with OECD countries in conventional final product markets. In other words, a significant share of growth in non-OECD countries has been driven by fragmentation of production and thus by the decisions taken by globalising firms. For example, the share of parts and components in total manufacturing exports from developing East Asia is much higher than for OECD countries (28% as compared with 17% for EU countries) and up to 40% for some countries, notably Malaysia, the Philippines and Singapore. The implication of this is that East Asian countries tend to be strongly (and

perhaps increasingly) dependent on production networks driven by multinationals located in OECD countries, rather than becoming more independent manufacturers. In other words, non-OECD countries tend to be location options for specific types of production process (though probably increasingly high value and complex segments of the production process) (Ernst, 2006).

Increasingly, the relocation of economic activities is also occurring so that product development (as well as production) is close to the major and less well-known markets in order to be responsive. According to this model, new technology and creativity in services are driven as much by consumer preferences in new markets as by innovation for existing markets. As such, a key factor in the choice of location for some industries is the use of expanding markets as test-beds and sources of product improvement and innovation. In the field of mobile communications, the Asian market for 3G services is expected to drive future innovation rather than continuing technological improvements originating from the industry's current concentrations in the United States, Finland and Sweden. The regional implications of this trend relate mainly to the potential refocusing of innovation related investment away from OECD hubs towards the development of new centres that are better able to respond to these market signals.

Sales in emerging markets are often at the very low cost end of the product ranges of major consumer goods (mobile handsets, TVs, cars, etc.), including "no frills, no features" models. Industry experts predict that demand is likely to grow rapidly for products that are less over-engineered and that address essential user needs neglected by market leaders that have tended to make new products more technology intensive. This new market is proving to be very lucrative. In the ICT sector, industry analysts expect that mobile products will be increasingly aimed at this lower income mass market. Most handset suppliers are already moving their base handset prices down from EUR 30-50 down to EUR 20 to gain access to this market. In a decade, analysts expect the price to have declined even further – to perhaps EUR 10 and even lower. Therefore, the strategy for the major handset suppliers has fundamentally changed. Those concentrating mainly on the high end, such as Samsung, have already seen their market share fall in 2006, while Nokia attributes its climb in market share to successful entry to the low end globally, which it had previously not focused on.

Analysis of the biopharmaceuticals, ICT and auto industries suggests that OECD producers are scrambling to move into these markets either directly or in co-operation with local partners.[4] There is some concern that if they do not do so, manufacturers from emerging economies such as China and India will exploit these profitable markets and then begin to target established markets in OECD countries with low-cost, technologically stripped-down products. This has already happened in some low technology consumer goods, such as the Giant bicycle brand (Berger, *et al.*, 2006). Two other examples in biopharma and ICT illustrate the potential for non-OECD countries firms to effectively penetrate these low-end markets in OECD countries.

- One of the most significant recent events in the pharmaceuticals industry was the February 2006 acquisition of Germany's fourth-largest generics manufacturer Betapharm by the Indian company Dr Reddy's. The sum involved (EUR 480 million) is not huge compared with many M&As in the pharmaceutical industry, but the other main bidder was also an Indian company, Ranbaxy, suggesting that in the generics market at least, new entrants from non-OECD countries are starting to challenge incumbents. This

is important because a significant number of major drugs and pharmaceuticals products are currently passing out of patent and entering the generics market.

- Chinese companies such as Huawei and ZTE are already undercutting prices of the traditional OECD telecommunications equipment vendors, and further low-cost technologies of a WiMax and mesh nature are expected. If these companies are successful in developing significant market weight, then they can be more active in developing and applying their own formats, standards and systems in competition with those used by current market leaders in OECD countries.

It was clear in the case study regions that the era of one-way investment is over and that investors from non-OECD countries are increasingly present in OECD regions. Regions in Sweden and Canada noted that production facilities in their region had recently been purchased by Asian manufacturers who were interested in acquiring new technologies and production processes. Even in Italy's industrial districts, the strong presence of Chinese investors has been noted. One report estimated that around 200 out of 3 200 clothing firms in the province of Modena are now Chinese owned (quoted in Berger, *et. al.*, 2005). The case study of Porto Digital in Brazil is interesting because while they are looking to bring in investment from abroad they are not focusing on ICT companies in the United States or in Europe but more on establishing alliances with investors from countries such as India, China and Russia.

Innovation offshoring: the key challenge for regions

As discussed above, an emerging business model emphasises the need to tap into market signals from emerging markets and develop products that respond to these high growth markets. The strategy is based on the geographical coincidence between low-cost production sites and key markets. A related phenomenon is innovation offshoring, which extends this model to the core R&D functions that until recently have taken place almost exclusively in OECD countries.

There is abundant evidence that R&D has been internationalised within the OECD area. The share of national manufacturing R&D expenditure accounted for by foreign-owned companies can be very high indeed, even in countries that have strong business R&D systems such as the United Kingdom and Sweden. In all countries included in the OECD survey (except Canada) the growth of R&D by foreign affiliates was faster than for domestic firms. Global corporations source R&D internationally for three main reasons: 1) the cost and complexity of technology development means that skilled partners have to be sourced from a wider area; 2) there are innovation hot-spots related to particular new technologies that are very location specific, and to be involved firms need a local presence; and 3) national R&D and innovation systems can be limited in scope and present "lock in" characteristics (OECD, 2006a).

As a result, global corporations are increasingly relying on innovation offshoring through global innovation networks, in OECD and non-OECD countries (Table 2.6). These networks are both global in reach but also tap into very local assets (Ernst, 2006). Large European ICT and biotechnology or pharmaceuticals companies will obviously have an R&D presence in Silicon Valley and Cambridge/Boston respectively in order to monitor trends. The case study regions show, however, that foreign-owned R&D labs are also present in smaller centres such as Montreal, Ottawa and Eindhoven. And while car production in the Detroit/south-east Michigan region is in crisis, the region remains a key

Table 2.6. **Foreign-controlled affiliates' share of manufacturing R&D expenditure: selected countries**

Country	%
Italy	37.3
Canada	37.9
United Kingdom	40.1
Sweden	41.2
Slovak Republic	41.5
Spain	42.6
Australia	45.4
Portugal	48.8
Czech Republic	59.0
Ireland	74.2
Hungary	77.1

Source: OECD (2006b), *Measuring Globalisation: OECD Economic Globalisation Indicators*, OECD Publications, Paris.

R&D hub for automotive research and a wide range of related technology fields, with foreign MNEs and major suppliers all having an R&D presence in the region.

Even apparently self-sufficient regional hubs are now internationalised to a large degree. Around a quarter of US biotech companies are located in two major Californian clusters, in San Diego and Los Angeles. But this does not mean that US biotech is inward looking. A study of biomedical alliances in 2001-2003 by the Center for Strategic Economic Studies shows that while US companies are extremely active in their home market, they are using alliances to make substantial product and technology or other acquisitions from continental Europe, the United Kingdom, and Canada (Rasmussen, 2004). The number of US alliances with these three countries was 508, roughly equivalent to 30% of the number of internal alliances within the United States. The United States is also a significant source of technology and product development for other countries in the field of biotechnology. There are 791 alliances to purchase from US "developers" by "client" firms in Europe (462), the United Kingdom (186), and Japan (143).

Until recently this internationalisation involved relatively few countries, almost entirely within the OECD. However, a 2005 survey of the world's largest R&D spenders found that China was identified as the most attractive location for future R&D. The leading global corporations that participated in the survey agreed that they intend to increase their offshore outsourcing of R&D to Asia. China is now the third most important offshore R&D location after the United States and the United Kingdom, with India sixth and Singapore ninth (PACTAD, 2005). The growth of Asian destinations has been very strong. For example, Asia's share in the overseas R&D by US firms has quadrupled from 3% of a total of USD 12 billion in 1994 to 12% out of USD 20 billion in 2002 (Ernst, 2006). The region's main attractions include lower-cost knowledge workers, large and increasingly sophisticated markets, and policies aimed at developing innovative capabilities. Global companies offshore stages of innovation to Asian affiliates to tap into the lower-cost talent pool and innovative capabilities of the region's leading export economies. This has led to the establishment of *intra-firm* global innovation networks (GINs). But global firms also outsource some stages of innovation to specialised Asian suppliers as part of complex *inter-firm* networks.

The expansion of Asian markets is an important motivation for major multinationals to have some product development capability in the region. Large corporations have already started moving some types of R&D closer to production sites, both with complete labs (*e.g.*, by Nokia, Ericsson, NEC, DoCoMo, Motorola, etc.). They also make investments in local small suppliers of advanced technology, such as when Motorola's venture capital arm invested in three Chinese wireless companies in March 2006 (FierceMoCo, 2006). Texas Instruments India provides a good example of how global firms have established integrated R&D labs in Asia that conduct leading-edge projects, including conceptualisation and architectural innovations (Ernst, 2006). The R&D centre opened in 1985 and by 1998 was responsible for the entire design process for certain chips. It now has a global development mandate for new products across a wide range of products and employs more than 2 500 researchers.

Once "upstream" facilities are established in specific locations in emerging markets, there appears to be a tendency to move to more demanding projects (in terms of greater integration of tasks and growing technological complexity). In order for MNEs to be able to recruit and retain key talent, they need to provide increasingly demanding projects. While MNEs used to dominate markets for top talent in China and India, they now need to compete with local firms. The increasing importance for MNEs of designing products that respond directly to the large markets in non-OECD countries is likely to speed up this process.

In other words: once local cluster development reaches a critical mass, there seems to be a qualitative change. A few years ago, survey research in China and India found a consensus that "the capacity to support and sustain core research is still relatively underdeveloped here", even in first-tier locations like Shanghai or Bangalore. That consensus now has been eroded. The issue now is whether (or how quickly) key firms (MNEs and domestic firms) in these locations will locate more demanding functions to these locations (Ernst, 2006). In these cases, lead firms will have a vested interest in seeing the density of the local innovation system or cluster increase. Several of the case study regions reported that local manufacturing firms had been bought up by either Chinese and Indian firms, probably in order to access technology and operational expertise in domestic hubs.

The R&D offshoring process is not limited to Asia. Eastern European countries and some other non-OECD counties have been targeted for investment in R&D and product development facilities both to help develop expanding markets in those countries/regions, and also as lower cost sites for design and development of products targeted to OECD countries. For example, many ICT companies are establishing software development centres in other emerging market economies in close proximity to clients. This move is often referred to as near-shoring and includes development centres in eastern Europe to service the western European market and Latin American countries to service the United States, Spain and Portugal.

In addition, firms from Korea, Taiwan, China, India and Singapore are also beginning to establish their own global innovation networks, focusing on accessing innovation hubs in OECD countries. Thus far, these Asian GINs are still at an early stage of their development, but their expansion seems to be gathering momentum. This trend has added a new dimension to Asia's network integration which is now moving beyond manufacturing to include research and product development. The expansion of Huawei's R&D system into the US and Sweden is a good example of the trend, and also illustrates the location-specific attributes that Huawei is looking for in its choice of R&D sites.

Table 2.7. **Huawei's Global Innovation Network**

Location	Main activity
Kista, Stockholm, Sweden	Base station architecture and system design, analogue-mixed signal systems, algorithms
Moscow, Russia	Algorithms, RF design
Bangalore, India	Embedded SW and platforms
Plano/Dallas, Texas, United States	Mobile data service, optical, VoIP

Source: Ernst, Dieter (2006), "Innovation Offshoring: Asia's Emerging Role in Global Innovation Networks", *East-West Center Special Report,* in co-operation with the US Asia-Pacific Council, July, *www.eastwestcenter.org/res-rp-publicationdetails.asp?pub_ID=2006*.

These deeper forms of network integration through inward and outward R&D investments are likely to pose new challenges for policies to support innovation in regions, but they might also provide new opportunities. Specifically, under what conditions can these two-way networks add sources of learning as well as business linkage opportunities for firms in OECD regions, hence broadening a region's options for innovation-led regional development strategies.

Whatever the long-term impacts for regions in the OECD, the evidence of strong market growth by non-OECD firms in research-intensive industries is clear. For example, developing countries have increased their share of foreign patent applications to the US Patent and Trademark Office (USPTO). Whereas developed countries in 2003 still accounted for 83% of all foreign patent applications to the USPTO, the share of developing countries and south-east Europe and the CIS has risen particularly fast. Between the periods 1991-1993 and 2001-2003, it jumped from 7% to 17%. The annual average number of applications from these countries increased from around 5 000 to almost 26 000 between the two periods (see Table 2.8).

Table 2.8. **Patent applications from developing countries and south-east Europe and CIS in the United States, by residence of inventor, 1991-2003**

Period averages

Region/economy	Average 1991-1993	Share of foreign (%)	Average 2001-2003	Share of foreign (%)	Change between periods (%)
Developing economies	5 121	6.63	25 322	16.78	394.5
Developed countries*	71 805	92.94	124 905	82.77	73.9
Domestic applications	93 445	..	183 566	..	96.4

Note: * In the new United Nations classification, the total for developed countries includes the new EU members.

Source: Original source: United States Patent and Trademark Office, Information Products Division, Technology Assessment and Forecast Branch, special tabulations, Washington, DC, February 2005.

Source: Adapted from UNCTAD (2005b), *World Investment Report 2005: Transnational Corporations and the Internationalization of R&D*, United Nations New York and Geneva, Table A.III.3, p. 321.

Future globalisation trends

The trends described above give an idea about how regional economies are changing and some of the evolutions in economic activity that lie behind these changes. Regions then have to decide what is a sound basis for decision-making on investment and strategy given these trends. At a regional level, the performance of firms can be affected by a number of external shocks or changes that are beyond the control of firms but that affect dramatically their competitiveness. Three such influences include: 1) changes in market demand; 2) disruptive technologies; and 3) uncertainties relating to globalisation process more generally.

Changes in market demand

Changes in market demand will alter the production location equation in the coming decades, with implications for firms in OECD countries. The rise of developing countries in world trade and investment will be increasingly related to changes in demand rather than simply participation in production. Overall, GDP per capita should increase faster in developing countries (3.5% p.a.) than in high income countries (2.4% p.a.). This combined with demographics suggests that the major growth in the medium term will come not in OECD markets but in certain emerging markets. Forecast market growth in the automotive industry, for example, for the period 2001 to 2020 shows the stark difference between market demand in different regions of the world (see Table 2.9). The region-level implications of this are not clear, other than that worldwide employment in car manufacturing is likely to increase, assuming no disruptive technologies or unforeseen market changes. The challenges involved in meeting demand in the car industry (see Box 2.2) are likely to be mirrored across the range of other commodity and consumer goods for which demand has been stable but is now expanding rapidly.

Table 2.9. **Regional market growth forecasts, automotive industry, to 2020**

Millions of cars

Region	2001	2005	2010	2020
North America	19.6	21.5	23.0	24.0
Western Europe	16.6	15.0	15.0	15.0
Asia Pacific	12.4	18.5	21.7	30.0
Central/eastern Europe	2.5	3.0	4.5	10.0
South America	2.4	3.0	4.0	7.0
Middle East	1.3	2.0	3.0	3.0
Africa	0.8	1.0	5.0	12.0
TOTAL	55.9	64.0	76.2	100.0

Source: Wells, Peter and Paul Nieuwenhuis (2006), "Global Outlook for the Automotive Sector: Future Drivers, Trends and Barriers", unpublished report, Centre for Automotive Industry Research and ESRC Centre for Business Relationships, Accountability, Sustainability and Society, Cardiff University.

Disruptive technologies

Regions, like firms, have to address the issue of disruptive technology and the impact that breakthrough technologies can have on regional economies. Classically, industrial locations generate economies of agglomeration. The co-location of related activities results in a dense network of suppliers, a workforce with the many and varied skills required, and the diverse milieu of supportive activities and businesses from machine tool suppliers to training consultancies. However, disruptive technologies can change this paradigm. New technologies can be either a huge windfall for a regional economy, as for example with Silicon Valley or, more recently, Helsinki's mobile phone industry and internet clusters in southern California. But new technologies can also be a significant threat, undermining the competitive advantage of established firms and regions.

These innovations are sometimes driven purely by invention, meaning the creation of a new process or product. But in the sectors reviewed here, they are also often a response to an external push such as new regulations, standard setting, environmental concern, etc. At the same time, nobody knows which technologies will emerge victorious in the long term. There are uncertainties over whether the technologies will work in a satisfactory

Box 2.2. **Meeting demand from emerging markets: the car industry**

Should expansion continue to occur in the key large, emerging markets around the world, there is a need both for new capacity and for that capacity to be in new locations. So, the market expansion requirement in a robust growth scenario is for a further 45 million units per annum output by 2020. This is roughly double the output of 2001. Also, capacity is rarely used at 100% all the time – though there has been some improvement in capacity utilisation over the last ten years. A good working assumption is that 75% utilisation of normal installed capacity is break-even for any one plant or the industry as a whole. At 75% capacity utilisation there would be a need for an installed vehicle assembly plant capacity of 60 million extra cars per annum by 2020 to meet currently expected demand.

In order to simplify the calculation, an average plant size of 400 000 units capacity per annum is assumed. On this basis, to expand capacity by 45 million units would require some 112 plants, while expansion to 60 million units would require a staggering 150 plants: or nine full-sized plants per annum from 2003 till the year 2020. Given a requirement to build 112 plants, this means a cumulative investment cost to the vehicle manufacturers of about USD 280 billion. With 150 plants that investment cost rises to USD 370 billion.

Souce: Wells, Peter and Paul Nieuwenhuis (2006), "Global Outlook for the Automotive Sector: Future Drivers, Trends and Barriers", unpublished report, Centre for Automotive Industry Research and ESRC Centre for Business Relationships, Accountability, Sustainability and Society, Cardiff University.

manner, over whether they will meet the demands of government regulators, and whether consumers will accept them, among other issues.

In the automotive industry, a disruptive technology has emerged in the form of the fuel cell. The current global centre of the fuel cell business is Vancouver not in Detroit or another of the major car producing regions. There is an emerging cluster of fuel cell related activities around Ballard, supported and promoted by the British Columbia regional government and by entities such as Fuel Cells Canada. A deliberate attempt has been made to leverage the first-mover advantages held by Vancouver, and thereby stake a claim in the potentially massive fuel cell market of the future. In effect, this is an attempt to emulate the Silicon Valley phenomenon.

While fuel cell cars are still some way from production, there are a whole range of new technical innovations in the power generation systems of vehicles that are being developed to respond to environmental and market demands. These might not reshape the industry as dramatically as fuel cells, but they could change the industrial landscape (and change the way the car industry interfaces with government and regulators). This is an example of an external driver being internalised by the industry and being turned into a competitive tool. In the long term, such a scenario will of course make the industry more sustainable, both from an economic and an environmental viewpoint. By implication, in the future individual vehicle manufacturers, their technology partner suppliers, and/or particular locations will be looking more aggressively to establish market technology leadership. In this sense, Toyota's promotion of hybrid engines could accelerate the deployment of fuel cell vehicles as the firm's clear strategy is to benefit from its first-comer advantage and its ability to help set standards.

Uncertainties concerning globalisation drivers

More generally, whether economic change will continue at the same rate in the future as in the past is an open question. Two of the main engines that drive globalisation – liberalisation and progress in transport – may run out of steam. Further liberalisation is increasingly difficult to achieve because the issues to be addressed are more controversial and more actors are involved in the decision-making process. Further expansion of transport – notably the two fastest increasing components of the transport sector (road and air transport) often appear to be largely unsustainable. Moreover, other factors such as geopolitics or security, environmental concerns such as climate change, or demographic change could slow or undermine the process in different ways.

Growing emissions of greenhouse gases, for example, is raising concern about environmental costs of current consumption patterns, leading to the implementation of measures that could influence the globalisation process in the future. On the one hand, globalisation of production could be adversely affected, for instance if the measures put in place contribute to curb traffic directly or raise the cost of transport. Moreover, concern over global warming may induce governments to impose trade sanctions on countries that do not meet basic environmental standards. On the other hand, given the global nature of the problem, there will be increasing pressures from state and non-state actors to implement global solutions, such as the creation of markets for emission trading rights and international co-operation for the development of clean energy sources. While these issues are not currently changing the way that the reorganisation of production is taking place, in the future they could have a strong influence on the economic logics that are driving the location of production at the moment.

Notes

1. The vast majority (87%) of regulatory changes tended to make conditions more favourable for foreign companies to enter and operate. Most of these measures implied further liberalisation of investment regimes; 95 of the measures involved new promotional efforts (including various types of incentives) and 37 greater investor protection. In terms of regional distribution, Asia and Oceania accounted for 30% of the new measures, followed by the transition economies (22%), Africa (21%), developed countries (14%) and Latin America and the Caribbean (13%) (UNCTAD, 2005a).
2. Theorists of the reorganisation of production often point to these cost and time savings as being the principal motors for reshaping production processes. Jones and Kierzkowski, for example, note that the increasing returns to scale of the functions that link dispersed production processes are the main source of productivity gain that make the process viable, or in other words, the quality of service links makes disagglomeration a viable alternative to agglomeration as the basis for industrial location (Jones and Kierzkowski, 2005).
3. Available research suggests that jobs lost to offshoring account for only a small percentage of aggregate job losses. According to the European Monitoring Centre on Change (EMCC) in Dublin, offshoring by European firms is responsible for less than 5% of total job losses in Europe, far behind bankruptcies, shut-downs and restructuring.
4. However, many industry experts are also still cautious about recommending partnerships between Western and Asian firms within the biotech sector. Ernst and Young, for example, state that merger and acquisition risk in China "still may be too high for many multinational companies to bear" (Ernst and Young, 2005). Boston Consulting Group echo this to some extent concerning biopharmaceuticals, insisting that outsourcing R&D to China is a strategic choice that signals commitment to the country and can help strengthen relationships with key opinion leaders and officials, but the report goes on to stress that this "won't achieve major cost savings for global biopharmaceuticals companies" (Wong, *et al.*, 2005).

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Can OECD Regions Complete in Global Industries?

PART I

Chapter 3

How Regions Compete: Building on Strengths and Identifying Opportunities

Given the changes in regional economies due to globalisation, the reorganisation of production and the nature of innovation, how should regions respond? Regions, not nations, appear increasingly as the nodes in global networks. Regions are also the scale at which meaningful interaction among firms, people and knowledge generators leads to innovation. This chapter discusses the opportunities that the reorganisation of production seems to offer and presents some examples of how regions have worked to seize these opportunities.

Introduction and key points

Developing strategies that will have an impact on the competitiveness of a given region involves identifying the sources or potential sources of the region's competitive advantage. As such, an extremely wide range of factors could be targets for policy. Many factors that affect the functioning of enterprises or that encourage investment are regulated through national policies that do not differentiate among regions; *i.e.*, that are based on legislative or regulatory frameworks that are region-neutral.

What then can individual regions do to compete? Of the region-specific factors that influence competitiveness, previous OECD work on regional strategies distinguished between direct, firm-related factors and indirect or business environment-related factors as being the main targets for policy (OECD, 2005a). This chapter therefore explores six policy strategies being used by many OECD regions to best adapt to the changes resulting from globalisation. Several of these policies seek to support different types of firms: globalising the customer base of existing firms, supporting a new role for innovative small firms or making the most of the presence of MNEs. Other policies are more focused on the regional environment: strengths in technology to support cross-overs from one industry to another, the regional innovation system and other measures of regional attractiveness.

Key points

- A principal message from this research is that OECD can compete in markets where they face increasing competition from emerging economies. The nature of production in OECD regions is, however, evolving and policy makers need to be aware of the implications of these changes.
- Regions studied for this report emphasised that their main comparative advantage was the innovativeness of their enterprise base.
- Firms are under pressure to develop innovative products and assimilate new technologies rapidly. Given that even large firms cannot do this effectively, the system of innovation is becoming less vertical and more open.
- The case studies demonstrate that there are new opportunities for suppliers to access new customers and break out of vertical systems, thereby offering greater incentives for SMEs to innovate. This is one of the key domains for public policy in the regions studied.
- Open innovation is becoming an important tool for large and small firms as they look for new ways to share risk and develop complex products and processes. The links between R&D institutions and firms could become more important as the process of innovation becomes less internal. Here, proximity remains an important asset. Firms underlined the positive impact of region-level interaction relating to innovation.
- However, global production networks are also important. R&D is increasingly internationalised and maintaining innovation networks across different countries is technically feasible. Regions are looking for ways to help local firms access global

partners and so the regional innovation system concept needs to be also an outward looking strategy.

Strategies to support firms

Globalising the customer base of existing firms

Regions underlined that the existing enterprise base, because of accumulated skills and technical capacities, remains an important asset. The new architecture of production potentially provides much greater scope for established firms to innovate and offers more incentives for them to do so. They are also able to work with a wider range of clients and to develop their own products and systems. These global opportunities represent a principal axis for policies to respond to region-level economic transformations. This finding was true even in regions facing strong competition and currently specialised in industries seen as vulnerable to offshoring.

A growing share of the value of the final product in many industries is generated by the supply chain. For example, 70-75% of the value of a new car is contributed by suppliers. The relationship between manufacturers and their supply chain is, therefore, critical for the competitiveness of the large firm. Globalisation allows large firms to source more widely than they could do before and as such offers them the opportunity to remake their supply chains. In numerous cases, the disruption of local supplier networks by this process has had serious consequences in terms of employment and firm closure rates at the regional level. At the same time, the demands of keeping a stream of up-to-date, innovative products on the market puts extra pressure on core firms to maximise the innovation potential of their suppliers. A key regional development assumption in recent years has been that segmentation of product markets can increase the value of good local supplier networks if those networks are high quality and reliable. In other words, despite the multitude of other options, firms need more and quicker turnaround and this limits their capacity to outsource some segments of production too far. The evidence from the case studies suggests that there are still many examples of MNEs retaining local sourcing networks.

In practice, there are a number of competing pressures that strain the relationship between suppliers and their main customers. Large firms have seen prices for many consumer goods fall and they are anxious to preserve their operating margins. One way to do this has been to squeeze input costs. Suppliers are also often vulnerable to price fluctuation in the commodity markets for basic materials such as steel. Large firms still expect suppliers to be close by and able to provide just-in-time assembled modules sequenced tightly into a finely orchestrated production process. On the other hand, suppliers see that manufacturers are actively looking to switch more of their purchasing budgets to locations such as eastern Europe, India and China. The attractions of low cost have to be balanced against increased risk of supply disruption from uneven quality, logistics difficulties, or an insufficient degree of technical competence.

This potential disengagement from locally embedded supply chains is an important concern for many regions. The indirect employment created by large firms, often across very diverse activities, can be considerably more than the direct employment in the firm or firms that are the main customers. For example, US employment in motor vehicle producing companies stands at around 250 000 while employment in auto parts companies is around 800 000. Regions such as Detroit/south-east Michigan and Turin,

where supply chains have been stable for a long time, have been particularly hard hit by the pressures acting on these local networks. When the customer firms expand, then the suppliers also benefit, but when the large firms contract, the suppliers are hit too. The US automotive parts and components industry expanded by more than 25% over the period 1990-2000. However, since 2000, a combination of the slowdown in sales by Ford, GM and Chrysler and competition from components produced overseas (parts imports have more than tripled since 1994) has resulted in a 17% fall in employment in the parts industry for a loss of around 175 000 jobs.

A key policy orientation in the regions is, therefore, to help these established and, in many cases, technically advanced supplier companies to expand their reach. The objective of these policies is not to break current supplier systems but rather to help supplier firms diversify. In Turin, a number of SMEs closed as a result of their inability to diversify their business activities, either toward other international automotive manufacturers or other industrial sectors. However, with support from the regional and local governments, a significant number have reinforced their relationship with Fiat, while also becoming specialised component suppliers to European car manufacturers such as Volkswagen, Daimler-Chrysler, BMW, and others. This has, over a short period of time reshaped the customer profile of the supplier fabric in the Turin region. A decade ago, around 75% of suppliers in Turin's automotive industry had only one main customer, Fiat. Ten years later, this is the case for only around 25% of suppliers. One of the current weaknesses of the Detroit/south-east Michigan region is that its supplier base is still considered to be too vertically oriented, although the customer base of suppliers around Detroit has also broadened significantly.

This policy approach is justified by observations that many supplier firms in industries like auto, pharmaceuticals and ICT are high-technology users and developers with established reputations, and as such constitute key assets for their regions. They also usually include medium-sized firms – a category of firms that case study regions unanimously noted were under-represented and often missed by policy programmes (which tend to focus on new business start ups). The sector reports confirm that in the case of the automotive, biopharmaceuticals and ICT industries, traditional supplier-customer relationships are being replaced by arrangements that could change the hierarchy of the supply chain and give new momentum for small and medium-sized firms. For the auto industry model, Table 3.1 illustrates the transitions in supplier management strategy and the structure of supply. While manufacturers now rely on an increasingly select group of suppliers for the majority of inputs, they also expect those suppliers to undertake R&D, manage their own supply base and have their own growth strategies. A similar model is emerging in the biopharmaceuticals industry.

Regional and local level policy makers see an increased demand for support from small and medium-sized firms that have strong technological capacity and that are anxious to capture new markets. Successfully managing this transition is crucial for regions because in practice many supplier firms are vulnerable. Some are highly specialised and can sell their expertise to other companies in the same industry or crossover into other industries. Others, however, are contract manufacturers whose output can often be replicated at lower cost by producers in emerging economies. Thus, while there are opportunities for some (and the evolution of Turin's supplier base is a good example), other medium and small firms in local supplier networks need help to move their businesses out of basic product or commodity supply, which is now increasingly

Table 3.1. **Transitions in procurement regimes**
Automotive industry

Item	Traditional	Lean	Extended enterprise
No. of suppliers per model or plant	2 000-3 000	200-300	20-30
Supplier status	Commodity	Tier one/module suppliers	System suppliers
Geographic spread of supply base	Local cluster	Regional cluster plus supplier parks	Global plus regional supplier hubs
R&D capacity of suppliers	Work to drawing	Black box, design to fit set parameters	Innovative solutions and on-vehicle integration
Management regime	Remote, adversarial, piece price basis	Interventionist, supplier performance optimisation	Outsourced, strategic focus, entire chain optimisation
Structure of supply side	Fragmented, process-orientated, small to medium firms	Tiered hierarchy, national boundaries	Emergent super-suppliers of global reach
Vertical integration	High, captive suppliers for major sub-assemblies	Reduced, captive suppliers seek external business	Selective integration for key technologies, otherwise reduced integration

Source: Wells, Peter and Paul Nieuwenhuis (2006), "Global Outlook for the Automotive Sector: Future Drivers, Trends and Barriers", unpublished report, Centre for Automotive Industry Research and ESRC Centre for Business Relationships, Accountability, Sustainability and Society, Cardiff University.

undertaken by firms in countries like China, and upgrade into higher value or more specialised products. One initiative is the EDA Center for Economic Diversification in Michigan, which provides a range of services funded in part by the Department of Commerce and delivered through the University of Michigan, to help the transformation of existing firms, as well as a range of other workforce reconversion measures (Box 3.1).

This does not, however, undermine the role of the anchor or lead firms in the region. A key point noted by policy makers was the importance of maintaining the role of the anchor firm as a key customer to ensure the overall stability of the supply chain firms. Evidence from sectoral analyses suggests that the diversification of suppliers was also seen as a positive evolution by large firms as well because it potentially increases the skills, technical capacity and management of the supplier firm in addition to reducing complacency, among other benefits.

Promoting a new role for SMEs in innovation

In the context of globalisation, the role of small firms in global industries has often been underestimated. The evidence from the sector reports and case studies shows clearly that in major global industries, the role of SMEs has not diminished. This supports the findings of other recent OECD work on SMEs (OECD, 2007g). The reorganisation of production seems to offer particular incentives for small firms to innovate, and regional policy makers are focusing on how to meet the demand from small firms and provide effective support that will help them to grow.

The findings from the different sectors suggest that small firms are often the prime source of innovative ideas that are integrated into other products or brought to market in their own right by large firms. There are diverse reasons for this. Those raised by the case studies included the following:

- Many of the most important innovations in manufacturing are adapted from other sectors outside the main competences of the manufacturers in that sector (*e.g.*, the increasing importance of computer software in cars, the use of data processing in biopharmaceuticals, etc.). In some cases, this demand for expertise is met by large

Box 3.1. **EDA Center for Economic Revitalisation, Michigan**

Funded in part by the US Department of Commerce, Economic Development Administration (EDA), the EDA University of Michigan Center for Economic Diversification was established to help the Michigan economy become more diversified. The centre's main goal is to assist communities and companies so that they become innovative, flexible, efficient and globally competitive. The support is provided through a range of analysis such as feasibility analyses, market analyses, strategic implementation, operations planning, and impact and performance analysis in five different areas: economic diversification, industrial facilities revitalisation, minority business development, professional education and training activities and international exporting and global competitiveness.

Economic Diversification activities involves strategic and due diligence initiatives for local communities, firms and entrepreneurs in order to identify and analyse opportunities for economic and community development project, new technological and emerging industrial sectors as well as new market niches in traditional industrial sectors. *Industrial Facilities Revitalization activities* are for example strategic advices for re-use of for closed facilities. *Minority Business Development* is assistance to newly formed and minority-owned firms so that they can benefit from the technological, educational, and research resources of the University of Michigan. *Professional Education and Training* activities include: information, briefings, and seminars addressing corporate diversification as well as international market opportunities. The *International Exporting and Global Competitiveness* area supports companies with expertise and information resources available within the University of Michigan regarding new market opportunities.

companies such as Microsoft, which work extensively with car makers, but it is also an opportunity for SMEs who can often be more agile in adapting existing technologies.

- Large firms in R&D intensive industries are seeing the productivity of their in-house research decline and are looking for ways to improve output and share risk, such as by cost sharing with SMEs instead of having to internalise product development (see Box 3.2).
- Small firms are often more aware of niches or emerging markets; for example, finding solutions to new legal or regulatory requirements.

Of the industries studied here, it is clear that SMEs play an increasingly central role in the innovation/high-tech strategies of the regions concerned. For example, within the biotechnology sector, there were a couple of examples of collective services focused on the capital intensive trial and testing stage. SMEs do not have the appropriate facilities for this stage of the innovation process nor access to the capital for this. Large firms increasingly push innovative smaller firms to take more responsibility for initial drug discovery and early stage trialling. While this provides good incentives and opportunities for SMEs, it also means that they face significant challenges in funding the development phases, particularly given the very strict regulatory environment for the sector. Angel investors and venture capital firms will take up some cases, but not all. And even where funding is available, the facilities and personnel to do the trials may not be. The Biotechvalley initiative in the Stockholm-Mälar region was valued because it filled a clear need among small firms such that the development reaches a stage where an investor is likely to

Box 3.2. **Why do large drug companies need small firms?**

The traditional business model for developing and marketing drugs features strong vertical integration from the laboratory to the point of sale in the hope of creating a blockbuster. In pharmaceuticals, only one compound in a thousand even makes it as far as the first stage of clinical trials. It takes over a decade for a new compound to reach the market as a drug, and an estimate based on data from 1983 to 2000 indicates that a typical new drug costs around USD 900 million to bring to market in a country such as the United States. Even this colossal sum may be an underestimate, with some analysts calculating a total almost twice as big (USD 1.7 billion) once indirect costs, costs of product launch, etc., are factored in.

The pharmaceutical value chain comprises four large sections: basic research and candidate identification; clinical trials; regulatory approval; and manufacturing and commercialisation. Given the time scale, expense, and complexity of the entire chain, only the large companies are involved at all stages. They are particularly strong in the last stages (Phase 3 trials, regulatory compliance, sales and marketing). Smaller companies, including almost all biotechnology enterprises, tend to be better at the early stages such as pure research or early Phase trials.

The coming decade is likely to see a drastic reduction in the number of traditional deals where big pharmaceutical companies buy and commercialise promising products in return for royalties and various other payments, while accepting most of the risk. A comparison of two deals, one from December 2005 and one from 2002 illustrates how the dynamics of drug development are changing.

- In a 2002 deal involving an insomnia compound, Pfizer paid Neurocrine USD 100 million upfront with an agreement to pay up to USD 300 million more in milestones and royalties of 26% to 30%. Pfizer was also committed to funding any remaining development costs and was responsible for the remaining risk.
- In a 2005 deal involving an atherosclerosis compound, AstraZeneca paid only USD 50 million upfront, with USD 300 million in development milestones, USD 650 million in sales milestones and royalties of 15% to 35%. AtheroGenics has to fund the Phase 3 trials.

For smaller biotechnology enterprises, cost-sharing arrangements hold out the promise of much larger income than present licensing deals if the product is successful, and a chance to move up the value chain towards new activities. But it also implies much greater, and more speculative, investment in the early stages of product development; *i.e.*, at a time when a small company may not have the resources to maintain its part of the bargain.

Source: Love, Patrick (2006), "Global Outlook for the Biotechnology Sector: Future Drivers, Trends and Barriers", unpublished report.

provide funding. It began as a biotechnology centre formed in Strängnäs in 1999 to give biotech and pharmaceuticals companies access to laboratory facilities for research and development projects. Shanghai's Science and Technology Commission is also supporting development of a drug trial facility that meets regulatory approval standards for use by SMEs looking to move to the next stage.

For large companies, joint ventures with smaller, specialised firms provide access to new products and specialist technologies (Arora, *et al.*, 2001). Alliances among small firms enable specialist companies to achieve the synergies needed to develop new products and services;

i.e., to transfer technology or other resources across the value chain. As shown in the case studies, this integration often starts out as geographic, helping to form clusters in innovation systems at local or regional level. The biopharmaceuticals industry illustrates the evolution. The number of big pharmaceuticals-smaller biotech alliances increased from 69 in 1993 to 502 in 2004. Equally significant, the number of biotech-biotech alliances was even higher.

The impact that the changing role of small firms will have on future industry structure is not clear yet. At one extreme, innovative small firms could simply remain suppliers of specialist technologies, with alliances providing the mechanism for technology transfer. And, of course, the option of buying out of the small firm by the large firm remains present, particularly where prototypes show particular promise or where the SME risks being bought out by another large firm. Alternatively, the range of informal and formal alliances acts as a temporary phase, providing the funding and other resources that small firms need to expand. In several of the regions studied, the issue of nurturing innovative SMEs through trialling and initial prototype development stages was a priority for policy, but with some frustration expressed that the SMEs were often bought out or sold off key technologies to large firms from outside the region before they could expand locally. Among the numerous examples of programmes to help young firms, the STING programme in Stockholm supports start ups in the ICT industry (Box 3.3).

Box 3.3. **Stockholm Innovation & Growth AB (STING)**

Stockholm Innovation & Growth AB (STING) is a subsidiary of the Electrum Foundation which manages the Kista Science Park in Stockholm. The aim of STING is to promote the best entrepreneurs and companies with a potential of growing abroad. STING has four main programmes: *Start Up* (a training programme for ICT entrepreneurs), *Business Lab* (a business pre-incubator for projects during very early phases of development), *Business Accelerator* (a business incubator for companies during the very early phases of development), and *Growth Programme* (a programme tailored to individual needs and conditions for established SMEs that require support for international expansion). Since 2002, 46 out of approximately 80 new technology-based firms established in Kista have been supported by STING. About 140 projects are assessed every year and 15 start-ups are fostered, which has tripled in five years.

Getting the most out of the presence of MNEs

Many regions are closely associated both with specific firms and with groups of firms working in particular sectors. The strong specialisation is an expression of the competitive advantage of those firms. The competitiveness of the region is recognised as being tied to the fortunes of the firms and the sectors. This can be a clear advantage in cases where the firms are market leaders or where the sectors are expanding. The growth of the regions featured in this report has been based on successfully supplying expanding demand for high volume consumer goods (automobiles, chemical and pharmaceutical products, and ICT equipment). These regions have become specialised in producing particular types of products over a long period over which skills, capital, infrastructure and other inputs have become increasingly dense. And they are also closely associated with firms that have been

market leaders – Roche, Ford, GM, Ericsson, Nortel, Philips, etc. As such, regional specialisation is often exemplified by a particular firm or small group of firms. In many cases, the regional economies have grown alongside the expansion of key firms, becoming specialised in the core business of the firm and building an enterprise base around supplying the key firm(s) with components and services. Over the past few decades, the regions have benefited significantly, in terms of both employment and wealth creation, from the ability of key firms to globalise their activities.

In turn, large firms have drawn on the specialised skills, services and other assets developed in the region in order to maintain their competitive edge, and generate innovative new products. In some cases, the attributes of firms have also become closely associated with qualities synonymous with the region (such as engineering tradition, specialised skills, creativity in design, etc.). Perhaps more than any other industry, the place of production is considered to be an important embedded value of the final product within the automotive industry. At least this is the case of the Västra Götaland region and Turin. These regions emphasise high value precision engineering and design features respectively as their market advantage. For example, the market positioning of Volvo in both car and truck markets depends on its reputation for quality and reliability derived from a peculiarly Swedish model. As such, within the Ford range of brands/companies, the Volvo car brand has a particular niche and that niche is closely linked to its place of production, the Västra Götaland region. The region has thus acquired a worldwide reputation for its advanced engineering tradition, its skilled workforce and the cold climate-tested durability of its manufactured goods. Similarly, Fiat is closely associated with design and a number of world-renowned design companies, notably Pinfarina, that work with Fiat. In both cases, there is a close association between the product or brand and the region.

At the same time, the reorganisation of production has meant that the ties between large firms and their home regions have in many cases loosened. The case study regions have all seen some form of downsizing by the region's largest enterprises, with segments of production being moved offshore and other parts of the enterprises spun off or sold.

The wave of mergers and acquisitions through the 1980s and 1990s in the three sectors reviewed by this research has, for example, altered the ownership structures of many of the multinationals, with decisions relating to business strategy now taken elsewhere. The ownership structure of Volvo Cars and Saab means that car production in the Västra Götaland region is dependent on the performance and subsequent business strategies of Ford and General Motors respectively. The situation is similar in most other industries. The attachment of Alcatel in Ottawa is not as strong as that of Nortel and the attachment of Pfizer in the Stockholm region is not as strong as that of Pharmacia, for example. Alliances can also alter relatively stable production location structures. For example, the partnership between Nissan and Renault now means that the French company has an influence on the location and output of Nissan car plants with respect to the location of its own production facilities.

At the same time, the downsizing of major firms, either due to internal restructuring or reorganisation after a merger, has been a key source of innovation in the regions. The withdrawal of Nortel from its semiconductor business and the subsequent layoff of a large number of skilled engineers and scientists are generally credited with being one of the springboards for the success of Ottawa's ICT sector and its transformation from reliance on Nortel as the major customer to a more diversified cluster structure. The same occurred in

Uppsala (Sweden) following the takeover of Pharmacia by Pfizer. The Uppsala biotech cluster was driven in part by former employees of Pharmacia who either left or were made redundant following the purchase. A similar process took place in the north-western Switzerland region – for example, the 1996 merger between the two locally based multinationals, Ciba-Geigy and Sandoz, became Novartis. In each case, these mergers have led to certain business areas being sold to other firms or becoming spin-offs. Hoffmann-LaRoche, for example, refocused its business on core competencies, triggering other spin-offs that have become significant actors in the industry, such as Basilea and Arpida.

The research seems to highlight the important role of large firms in training future entrepreneurs at the regional level. One issue that is not usually recognised is that large firms are often repositories of underutilised (or undermotivated) innovation capacity. In Ottawa, the Basel region and the Stockholm region, the downsizing of large firms released entrepreneurial talent that was then able to generate large numbers of new small firms that were free to develop technologies for the market. In some cases, the basic R&D for the inventions had been done within the large firm but was not commercialised and it was only once the firm had shed certain branches of its activities that these technologies were developed by former employees on their own.

Initiatives to support regional firms often struggle with how to design policy actions that serve the needs of both small and large firms. A review of cluster promotion policies, for example, noted the very different utilisation of public programmes based on firm sizes (OECD, 2007a). Public support for SMEs can be more easily justified because market failures tend to provide a rationale for public support to overcome problems of access and asymmetries of information that affect SMEs more than other firms. Nevertheless, it is clear that regions still depend on key anchor firms and are anxious to engage them in public policy dialogue and provide suitable supports where needed.

In general terms, large firms are not interested in public support beyond that which affects framework conditions or directly impacts on factor prices. The extent of their interaction with or participation in public programmes depends on the sector and type of activity. Firms engaged in production are mainly interested in factor prices and will be concerned by direct incentives (provision of land and infrastructure, etc.). For example, several large firms engaged in ICT and pharmaceutical production in Sweden and in Canada confirmed that they are not encouraged by their headquarters to join in the public programmes. Nevertheless there were counter examples.

However, larger firms did participate in public or private initiatives for several reasons related closely to the reorganisation of production and the emphasis on open innovation. Often the largest anchor firms in the cluster are lead members of the cluster initiative. The rationale for their participation varied. It may be to monitor small and dynamic firms that they could work with. AstraZeneca is a prominent member of one of the Stockholm's main biotech cluster associations and Ericsson and IBM of Kista's Science City foundation. The Philips example showed a clear commercial interest in supporting other local firms, their innovations being of potential use to the firm.

Improving the regional environment

Focusing on (cross-over) technology rather than industry sector

In each of the three sectors studied, the assumption that there are separate sectors with their own technologies and methods has changed considerably. There is, for example,

strong interdependence between ICT and biopharmaceuticals and between ICT and automotive. Regions are emphasising the opportunities for regional firms to move beyond sectoral boundaries, thereby broadening the technological and skill base of the region as a whole. Two examples illustrate the opportunities associated with linking these different technologies.

Advances in different areas of biotechnology research (in particular genomics, stem cell research, and gene therapy) are producing a huge amount of data, which will remain largely unexploited unless efficient processing tools are available. Bioinformatics uses computers to store, classify, search, analyse and retrieve this data and turn it into useful information. As well as its technical importance, bioinformatics is an economically valuable sector in its own right. According to a report by industry analysts, the worldwide value of bioinformatics is expected to increase from USD 1.02 billion in 2002 to USD 3.0 billion in 2010, at an average annual growth rate of 15.8% (BCC, 2005). The fastest growing market is expected to be analysis software and services, from USD 444.7 million in 2005 to USD 1.2 billion in 2010. The application of bioinformatics in drug discovery and development is expected to reduce the annual cost of developing a new drug by 33%, and the time for drug discovery by 30%. Although the actual drug itself remains the biggest source of profit, an integrated package of diagnostics and other complementary products and services to make the therapy more effective, so-called personalised medicine, is likely to become an increasingly valuable part of the value chain.

The car industry is currently integrating a large range of new sensing systems that use ICT technologies to improve road safety. These systems include driver monitoring devices, head-up displays, night vision systems, pedestrian impact systems, and vehicle proximity (distance keeping) radar. In addition, there will be more interaction with the infrastructure to provide drivers with information about road and weather conditions, active lane control, automated emergency call out, vehicle speed control and convoying systems.

As such, more of the value of a product is derived from technology brought in from outside the sector. As discussed above, suppliers contribute much of the innovation for these sub-systems and have a wider range of applications for their technology or products, providing them with many opportunities to recoup investments in R&D. Small software or telematics firms can expand by supplying various applications and services to exploit a core product, whether it is a washing machine, a car or a medical treatment.

The fact that technologies cross over so much more from one sector to another is clearly important for regions looking to diversify and valorise innovation, but there exist significant challenges. Several regions examined in this report emphasise investment in enabling technologies related to their main traditional sectors but with far wider potential applications (*e.g.*, telematics and safety technologies developed for the car industry in Västra Götaland, road sensing technologies in Turin). However, the ICT industry is very prone to disruptive technologies and has a business model that takes this into account. Other sectors are often less adaptable. Manufacturers from other sectors take a chance that as they modify their products to take on board these new technologies, they are not overtaken by yet more innovation that renders the current modifications obsolete. A similar dilemma exists for public policy as well.

While the combination of different technologies is increasingly important to innovation, this was only the explicit focus of public action in a couple of the automotive regions. Although the firms interviewed did not highlight this initiative, in Turin the

regional government seeks to contribute to the economic transformation of the region. Their vehicle to facilitate the transition of regional firms to higher technology- and knowledge-intensive forms of economic activity is a "platform" for certain key sectors, including automotive. For instance, SMEs with high levels of specialisation in the automotive sector could, with appropriate reconfiguration of their business competencies and skills composition, diversify their activities toward the aeronautics industry. In Västra Götaland, two public initiatives serve to implement the regional growth strategy and have links across clusters. They support joint auto testing facilities as well as other technology linkages such as intelligent textiles and vehicle testing initiatives, bringing together automotive, ICT and textiles.

Similar efforts to recycle technologies in new industries or to use technological innovation to bridge across sectors were observable in other regions, such as the photonics cluster related to ICT in Ottawa. The photonics cluster was badly affected by the ICT downturn as most of the customers for photonics were ICT enterprises. The region is trying to rebuild the cluster by emphasising converging technologies, particularly with respect to life sciences where biophotonics is considered to be a cross-over technology application with major commercial potential. According to a recent report on converging technologies within the region, the local ICT sector has the technical and managerial capacity to exploit converging technology opportunities and in so doing would strengthen the life sciences cluster by helping to develop new market niches (biophotonics and medical wireless applications in particular) (Graytek, 2004).

These opportunities raise the question of the right strategic focus of investment in the regions: whether to reinvest in existing competitive sectors or to gamble on developing new technology fields. In part, the blurring of the lines between different sectors is encouraging this emphasis on finding new applications for technologies developed or strongly embedded in regions. For regions with a strong specialisation in industries that have changed little over recent decades, such as the auto industry (see Box 3.4) or the chemicals/pharmaceuticals industry, this is a relatively new phenomenon. In the case of biopharmaceuticals, the revolution is clearly being driven by the biotech sub-sector with its seemingly limitless applications. For regions such as Eindhoven that have spent the last century innovating in rapidly evolving consumer goods markets, the technology cross-over approach is an integral part of the business model.

Box 3.4. **Automation Alley, Michigan**

Automation Alley is a technology cluster networking companies linked through technology providing a brand separate from Detroit. Its members include organisations from business, university and research, and government. The cluster seeks to address some of the concerns of the automotive sector while focusing on synergies across developments in the industry and knowledge-intensive activities. For instance, the automotive sector has been a magnet for ICT in the region. The organisation has conducted a quantitative mapping study to determine the areas of strength of south-east Michigan. Its emphasis is on education, especially in middle levels of applied sciences and the development of new skills in advanced applications within the automotive sector, but also in emerging sectors. As such Automation Alley functions as a nodal point for the development of key competencies and their networking on a cross-sector regional basis.

It also appears that regions are actively marketing themselves more in terms of technology capacity than in terms of sectoral strengths as such. They emphasise re-branding in terms of adaptable skills and knowledge intensive enterprises, rather than strengths as an industry hub as such. The Global Marketing initiative operated by the economic development corporation in Ottawa, OCRI, is seeking to re-brand the region from a somewhat sleepy government town into an attractive ICT centre, while also stressing that the enterprise base is not defined by Nortel's activities but is much broader and covers an increasingly wide range of technologies.

Regional innovation systems

The regions emphasised that innovation capacity remains a prime asset and a focus for policy. Universities could increase their openness to problems and research demands formulated in industry to address commercialisation needs, a major issue in the biotech sector. Europe's biotech sector has pioneered many of the advances that are shaping modern biotechnology, but commercially it lags behind the United States due to the small size of firms and difficulty attracting the investment needed to develop research through to marketable products. The commercialisation of R&D results must in general be speeded up and intensified in all regions.

The concept of the regional innovation system has been widely embraced across the OECD. The underlying assumption is that a strong regional innovation system promotes competitiveness and growth and is characterised by good framework conditions, strong capacity among both knowledge generators users, and public policies that try to strengthen systemic linkages between key actors in the region. Most authors now emphasise that innovation is the result of an interactive learning process that involves often several actors from inside and outside the companies (Simmie, *et al.*, 2002). As well as being a *social* process, some authors also emphasise that it is an essentially *local* process. For example, "innovation is in general a groping, uncertain, cumulative and path dependent process: knowledge is spatially 'sticky' and tacit knowledge, despite the growth of knowledge management tools, is not easily communicated other than through personal interaction in a context of shared experiences" (Morgan, quoted in Amin, 2003).

The innovation system is increasingly important as innovation has become a more external and less closed process. In this open innovation approach, firms select and acquire technology from a wide range of external sources, they outsource portions of R&D and engage in partnerships to develop new technologies (see Table 3.2). The main internal function of the firm is to manage the technology onto the market. According to the US National Science Board, "the speed, complexity, and multi-disciplinary nature of scientific research, coupled with the increased relevance of science and the demands of a globally competitive environment, have … encouraged an innovation system increasingly characterized by networking and feedback among R&D performers, technology users, and their suppliers and across industries and national boundaries." (National Science Board, 2004). As was discussed earlier, a key evolution in this system is the changing role of supplier companies, which are in some cases as active as their customers in the field of product innovation. For instance, a study conducted by IBM Global Business Services with leading global corporations finds that a combination of suppliers, partners and customers is a more significant source of innovation than a company's employees and far more important than in-house R&D (see also von Hippel, 2005 and Chesbrough, 2003).

Table 3.2. **Closed and open innovation principles**

Closed innovation principles	Open innovation principles
The smart people in our field work for us.	Not all the smart people work for us. We need to work with smart people inside *and* outside our company.
To profit from R&D, we must discover it, develop it, and ship it ourselves.	External R&D can create significant value; internal R&D is needed to claim some portion of that value.
If we discover it ourselves, we will get it to market first.	We don't have to originate the research to profit from it.
The company that gets an innovation to market first will win.	Building a better business model is better than getting to market first.
If we create the most and the best ideas in the industry, we will win.	If we make the best use of internal and external ideas, we will win.
We should control our intellectual property, so that our competitors don't profit from our ideas.	We should profit from others' use of our IP, and we should buy others' intellectual property whenever it advances our own business model.

Source: Chesbrough, Henry (2003), *Open Innovation: The New Imperative for Creating and Profiting from Technology*, Harvard Business School Press, Boston.

The issue for regional policy makers is where their own research efforts, or those of the national level in the region, fit in to these dynamic arrangements. A key dilemma for regions is how to invest in R&D in such a way that at least part of the benefit is captured within the region in some form. With looser networks that involve firms with more global reach, it is unclear how to estimate the return on investment made by the public sector in support of private initiatives. At a strategic level, there are initiatives to create regional innovation system institutions that try to act as a mechanism to maintain links between different actors. The Brainport initiative in the Eindhoven region has this system supporting function as one its main missions (Box 3.5), as does OCRI in Ottawa.

The initiatives of the regions appear to focus mainly on trying to orient publicly funded or managed knowledge assets in such a way that they are better able to engage in joint activities with private firms. These assets are mainly national or regional research institutes or major universities and higher education institutions. The influence of these bodies in practice varied widely from one region to another and also with respect to sector. The methods used include: 1) promoting co-location of R&D generators alongside private

Box 3.5. **Brainport: Eindhoven**

During the last 15 years three comprehensive programmes have been initiated in the Eindhoven region. These are Stimulus, Horizon and most recently Brainport. The Brainport Programme aims to strengthen the economic development as well as the knowledge infrastructure of the Eindhoven-Leuven-Aachen triangle. It is public-private funded by its triple helix partners and is run in parallel with activities of the regional economic development agency (REDE). The initiative covers 21 municipalities in south-east Brabant but has a wider geographic scope than the boundaries of its constituent municipalities.

Brainport works as a development platform promoting vertical collaboration between governments and authorities on different levels. It also supports horizontal collaboration between companies and research and knowledge institutes within the region, and between different regions. The major role of Brainport Eindhoven is to enable and to facilitate strategic economic development. Issues on the agenda are: promotion of open innovation (collaboration on an international level between companies and research institutions), creation of centres of excellence, a balanced labour market, attracting venture capital, improvement of manufacturing companies' conditions in order to attract new investment, and strengthening the knowledge exchange between medium-sized and small firms.

firms (in science parks and similar structures); 2) promoting joint R&D and pushing universities and research labs to emphasise commercial applications; and 3) supporting open innovation platforms and privately managed R&D centres.

Promoting co-location

Among the longest established policy instruments for promoting regional research and innovation capacity is the creation of high-tech industrial spaces to provide a supportive business location for innovative firms. The development of technopoles and science parks goes back to the success of market-driven technology agglomerations like Silicon Valley and Route 128. The success of these regions made them best practice examples that other regions tried to imitate. A wave of publicly supported technopoles emerged in the 1970s and 1980s, with ambitious targets and correspondingly big sites and budgets – Research Triangle in North Carolina and Sophia Antipolis in France are two well-known examples. These models triggered a variety of more modest adaptations of the model, tailored to the means of the regions adopting them. The fact that firms like Apple and Hewlett Packard grew up in such environments has certainly added credence to the theory that co-location is beneficial for innovative small firms. These parks appeared to play the most catalytic role in the developing country context in driving an accelerated co-location of firms.

Shanghai's universities and pubic research institutes (from both national and regional funding sources) have taken an active role in locating both in the automotive and biotech parks to reinforce the strength of linkages. In fact, the promotion of such "platforms" is now one of the government's priorities in terms of improving outputs from S&T policies. These linkages are a new strategy beyond co-location in designated zones and parks.[1] Those that are termed science parks in China have evolved over time from being more focused on high-technology manufacturing exports to include entities that more clearly support endogenous innovation. This evolution can be seen with respect to more than 40 National University Science Parks launched since 2000 to serve as a base for research centres, both Chinese and those from MNEs, as well as offering services like support with intellectual property licensing for firms located within the parks.

The science parks also play a role for branding and some firms said that it increased its legitimacy and access to resources to be situated within the science park. This is true, for example, for small firms in Kista in Stockholm and for firms located in Porto Digital facilities in Recife. In Västra Götaland, two multi-disciplinary science parks serve as the focus for initiatives to support the automotive sector and one of them includes Volvo AB's research facilities. But the broad technology focus of the region's science parks is also designed to ensure that other technology fields are supported as well. In this respect, the science park model is used as a vehicle to draw in funding from national R&D sources for these new technology research areas.

Finally, the science and industrial parks promoted by regions, typically cities within the region, are a hub for policy delivery to clusters, often much broader than the park itself. In the ICT sector, Porto Digital in Recife, Kista in Stockholm and to a lesser extent Mi-Plaza in Eindhoven all had the most prominent parts of the cluster concentrated in one park. Many firms saw advantages such as proximity to a pool of skilled labour. Firms across regions also spoke of the pragmatic aspects of public support via these parks in terms of spatial planning or local transportation access for commuters.

Promoting joint R&D and commercialisation

Public R&D facilities play a central role in the biotech clusters, and to a lesser extent with the ICT and auto clusters. Biomedical research has a strong basic research component, is expensive and has uncertain commercial applications but often clear social benefits. As such, publicly funded R&D remains important in the industry, even where drug companies themselves invest heavily in R&D. The ICT sector evolves faster and is much more focused on rapid product innovation. As such, it is often difficult for public R&D to play a leading role at this stage. In the ICT cluster in Stockholm, for example, there were few links with nationally sponsored research centres. FOI, the Swedish Defence Research Agency, recently located to the park on its own initiative and some firms were enthusiastic about this co-location but mechanisms for co-operation had not yet been established. In the case of Ottawa, national research facilities were instrumental in developing key technologies with telecommunications applications and served as a key driver for the establishment of the region's specialisation in ICT. Today, however, they appear to play a less central role in the cluster.

While specialised regions tend to have higher education institutions that work with local firms, the existence of an academia-business gap was mentioned in several of the regions studied. One of the components of this gap is the mismatch between the education provided and the current needs of local firms. For example, for the ICT cluster in Sweden, the Royal Institute of Technology placed a branch within the Kista science park. However, the curriculum of the programme which focused on precision engineering grew obsolete as the cluster transitioned away from telecom equipment and towards ICT support systems (programming, multimedia, network services, etc.). Furthermore, the timeframes for academic programmes did not match the needs of firms, either in terms of overall curriculum or specific doctoral projects with industry.

The degree of academic-mismatch might be even greater in the ICT sector because of the very rapid evolution of technology in the sector and the highly commercial nature of the sector's R&D. Given that research in biopharmaceuticals is more capital intensive and more dependent on basic research, the links between research generators and firms tends to be more stable. For example, the presence of research universities in the Uppsala area of the Stockholm-Mälar region is considered to be a key motor for the development of new molecules and compounds commercialised by the drug companies in the region and elsewhere. The success of Uppsala Bio in Sweden is built upon the fact that the firms are the driving force with support from the universities. One strategic area, Uppsala BIO-X, is a cross-disciplinary research effort for biotech. The aim of the effort is to create new business opportunities from collaborative research efforts between academia and industry.

Promoting open innovation

In order to promote the open innovation concept and make the R&D system more private sector driven, regions also support privately managed R&D facilities. These tend to be led by or based around the existing facilities of large firms. For example, the Fiat research centre in Turin, which employs over 900 people, is a catalyst for R&D activity in the region. Although it focuses on its core business, the Fiat research centre nonetheless provides much of the momentum for R&D efforts in and around Turin across a range of fields. A key strategy of the Turin region is to try to involve a range of other firms in the R&D efforts that public labs and Fiat undertake in order to encourage a more open innovation system. Philips in the Eindhoven region has opened some technical R&D facilities for other companies to promote open innovation through pre-competitive R&D (see Box 3.6).

Box 3.6. **High-Tech Campus/MiPlaza, Eindhoven**

Though Philips is a worldwide operation, the company still has its major businesses in Eindhoven. At the end of the 1990s, the company moved all R&D activities to one place and in the timeframe 1999-2007 invested about USD 700 million in High Tech Campus Eindhoven. However, the company has moved its headquarters to Amsterdam, partly due to lack of qualified labour with specific skills. On High Tech Campus Eindhoven, the open facilities centre MiPlaza was equipped with state-of-the-art facilities, such as laboratories and clean rooms. It is fully owned by Philips, but today it is open to other firms, offering open innovation opportunities for pre-competitive R&D. MiPlaza employs some 250 to 300 experts in ICT which represents 10% of the ICT experts on the High Tech Campus. Over 50 companies are based there, employing over 5 500 researchers with numbers growing to over 8 000 over the upcoming years. Of these employees, 2 500 are experts in ICT (*i.e.*, at NXP, Philips, Holst Centre).

Other measures of regional attractiveness

A primary consideration for regions is the actions that they can take to support the regional environment generally, in terms of physical, human capital and, as discussed above, other innovation assets. Many of the overall regional strategies focus generally on the attractiveness of the region for residents and the business community. The common denominator in current thinking about territorial policy – including in relation to knowledge and innovation – is an emphasis on place-specific externalities based on exploiting unused potential. Policy instruments now tend to focus on providing collective goods that improve what has been termed the enabling environment or the quality of place – the attractiveness and functioning of the region as a whole.

In theory, investment in the regional environment should trigger positive externalities that already exist in the region and these should produce growth effects via more intense and productive economic activity. The issue for policy makers is to identify the possible sources of externalities in regions where economic activity is, for one reason or another, constrained (for example because of remoteness, because of location in a deprived urban area, or because of the presence of political administrative borders).

Infrastructure and accessibility

Investment in the enabling environment continues to emphasise physical investment. However, the constraints on infrastructure investment are increasing. In particular, the proportion of total investment that will need to be allocated to maintenance is increasing rapidly, as are the costs of new infrastructure. As a result, policy makers are seeking more cost-effective strategies.

Infrastructure concerns were expressed in many of the case study regions. Prominent among them were regions in the ICT sector, which could be due to the relative self-sufficiency of the sector whereby firms are more concerned with framework conditions than targeted public support. For example, while the Netherlands is a logistics gateway in Europe around the Randstad area, which includes Amsterdam and Rotterdam, the Eindhoven region is not as well served by the different transport modes. This was one of the key concerns of firms and local development authorities. In Ottawa, the lack of direct

flights to Europe (other than to London) and northern California was viewed as a problem for the cluster. Silicon Valley is Ottawa's largest business partner and the largest source of foreign venture capital.

The main metropolitan regions, in turn, tend to be more concerned with accessibility within the urban region. In Stockholm, for example, while the ICT cluster is predominantly located in a science/industrial park on an axis between the airport and the city centre, the high-speed airport access does not stop there. Infrastructure is also considered as a key requirement for future success in Recife. Infrastructure takes up a big part in the regional strategy and one of the main actions includes restoring the old harbour area.

Human capital assets: brain gain and brain drain

The quality of the labour force is increasingly important as OECD regional economies continue to transition to higher value added manufacturing and services. The local labour supply is a key criterion, if not the primary consideration in some cases, for firm location for high value added functions. Consequently, the market for knowledge workers often extends beyond a particular region and is increasingly global. Regions are confronted with three basic challenges to meet their labour force needs: 1) ensuring training of the regional population; 2) retaining trained students and workers from leaving; and 3) attracting workers from outside the region. Each one of these options entails a potentially different set of policy tools, although regional attractiveness is certainly important to all three.

The research revealed that the skills issue is not only a long-term concern but is also an immediate bottleneck that has consequences for firms and their strategies. In Sweden and in Switzerland, both regions where key firms noted that the pool of skilled labour was a major locational advantage, there was a reported shortage of trained engineers and scientists. Such skilled labour shortages are perceived to become even more acute in the future. For example, industry specialists in ICT have been concerned that offshoring of engineering jobs to Asia could have the effect of dissuading people from studying these subjects.

The brain gain may come from migration of already skilled workers or students that move to the region and remain upon graduation. The ability to attract foreign students and knowledge workers is affected by numerous restrictions and disincentives that are typically the realm of national level, and not regional level, policy. The issue of work permits for foreign scientists and key managers, and the need to extend tax breaks for them, were raised as an impediment in Sweden. The Eindhoven region is highly dependent on attracting skilled labour from outside the country for firms and research institutes, and hence the national procedures for enabling that immigration.

Even for the United States, which has the largest number of foreign students and knowledge workers in the OECD, immigration of skilled foreign knowledge workers is a contentious issue. Industry associations and the big research universities support a substantial increase in the number of entry permits for highly skilled professionals. The American Electronics Association, for example, has argued that the United States "…needs to decrease the bureaucratic and regulatory barriers delaying, preventing, and discharging high-skilled workers from entering the U.S. workforce. … Immigration is a critical component for maintaining a strong and vibrant technological workforce" (American Electronics Association, 2005).

This message was repeated in other countries as well. Regions can do little to influence national policies in these fields, but they do see themselves as being in a fierce

competition with other regions to attract and retain key workers. As such, the issue is high on the policy agendas of regions. Work by OECD on the role of higher education institutions in regional development has shown that regions and associations representing higher education institutions are very active in lobbying for changes in regulations governing foreign students and their ability to obtain work permits upon graduation (OECD, 2007b).

Brain drain was raised by firms and public actors in a couple of regions that are lagging relative to other regions in their respective countries. Interviews in Detroit/south-east Michigan confirmed that the most adaptable young people were thought to have moved out of the region and that the older population was less able to adapt to new career paths. In Brazil, many students did not remain in Pernambuco upon completion of studies. They moved to the South in search of better job opportunities with higher salaries. This brain drain was viewed as a challenge for Recife and a threat to the development of the region.

Some trained and qualified employees may have a business incentive to leave the region but remain rather than relocate for personal or quality of life reasons. Ottawa, for example, has made a major effort to sell its quality of life advantages to key workers (the city as a place to raise a family, etc.), as has Västra Götaland. There were several examples in the region of SMEs that could already have been relocated to larger centres but where the entrepreneur in question preferred to remain in the region. Alternatively, there were other examples where the SME was bought out by US or other Canadian firms and the entrepreneur reinvested the proceeds in launching another local innovation-based company to become a serial entrepreneur. There is no doubt that one motivation behind this pattern of entrepreneurship is the preference to remain in a particular location and not to relocate for expansion.

Note

1. The different nationally designated parks in China can be classified by both size and driver. In terms of size categories, there are: five large-sized Special Economic Zones, 32 mid-sized High and New Technology Industrial Development Zones (HNTIDZ) and 58 Science Parks. In terms of driver, there are: parks that serve as regional hubs designated by the country, hubs to carry out national S&T programmes, parks that integrate the above two categories for national strategic purposes, parks initiated by demand factors like university run science parks, and foreign initiative parks (Park and Hong, 2005).

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Can OECD Regions Complete in Global Industries?

PART I

Chapter 4

Clear Strategy, Good Governance

This chapter explores the importance of governance arrangements in helping regions react to changes in the global economy. In some cases, mobilisation has been a response to crisis; in others a more structured mechanism for economic policy formulation is used. In either case, the evidence base necessary for decision making stands out as a crucial issue, as does the ability of public and private sector actors to find consensus around a forward-looking and realistic response.

Introduction and key points

Regional competitiveness is attributable to numerous factors, some of which regional actors have the power to address. One area where policy does play a role is in the provision of "local collective competition goods" of value to firms (Crouch, *et al.*, 2001). Such goods may concern availability of relevant skills, access to information related to technical evolution or external markets, the sharing of a regional label, etc. These collective goods and services provide competitive capacity to the actors located in the place. Their provision must be ensured by social or political arrangements, strongly linked to the central government regional policy (objectives and means), that is, by forms of multi-level governance. This chapter explores the key elements in determining a possible regional response, both in terms of strategy and the governance arrangements that make it possible to design and implement a strategy.

Key points

- Different forms of economic shock provided a catalyst for some regions to develop more forward-looking strategies and motivate participants in the strategy development process. A more systematic approach to anticipating change is probably needed.
- Because region-level data, particularly in the field of innovation, are relatively weak, the evidence base by which regions can compare their position with other regions and track changes in the enterprise base tends to be weak.
- Where there is no specific crisis, the evolution discussed above could be sufficiently incremental to be missed by policy makers. This argues for an approach that is proactive in terms of a regular regional economic "check up".
- Given that functional economic regions do not always map to administrative boundaries, a variety of strategies are used to define the regional unit of intervention. These spatial footprints may vary by industry or by cluster within the same region. Furthermore, the tools available to the regional level differ considerably across institutional frameworks.
- The process to develop the regional strategy can be helpful in building consensus on the problems and possible solutions for the region's economic development. There were challenges for regions when the regional plans did not sufficiently convince those actors with resources.

What is the region?

One of the first challenges for mobilising regional support to enhance economic strengths is the definition of the region. The mismatch between the political administrative boundaries and the functional economic region can be a serious barrier to building competitive regions (OECD, 2005a). The development and implementation of a strategy to support the region's economic strengths is often a key step in designing an approach that takes into account this functional area. However, co-operation among

different public actors may be difficult to achieve. The development of an organised public response for the region seems to be an important first step. But this does not mean that such a response is required in all cases nor that if there is an organised response that it will be successful. The case study regions have developed their regional strategies in very different ways, reflecting the different mandates of the public actors and the degree of overlap between political and functional boundaries (see Table 4.1).

Mismatches between administrative and functional areas

No co-ordination body

The example of Stockholm illustrates an interesting point about the way that political boundaries can influence the type of support that public authorities provide for key industries. The fact that the spatial footprints of the biotech and ICT industries are different has important implications for public support. In the case of ICT, a strategic part of the cluster is largely contained around an industrial park within the City (and therefore County) of Stockholm. In contrast, the biotech cluster spans three counties in the greater Stockholm-Mälar region, a fact that is considered to impede co-ordination. While co-ordination across the three counties is weak, some bottom-up initiatives in different counties are seeking to bridge the gap, such as Biotechvalley and Uppsala Bio, to improve coherence in the strategic provision of support for the pharmaceuticals and biotechnology industries. However, no public actor has taken the role of "intra-regional leader" to link these initiatives.

With respect to horizontal co-ordination (across local government boundaries), the case of north-western Switzerland illustrates an even greater challenge to defining a region. First, the biopharmaceutical cluster spans areas in three countries, Switzerland, Germany and France. Second, the definition of the region varies by purpose, and a number of different geographical definitions (or footprints) are used. This "variable geometry" and purpose-oriented delimitation of north-western Switzerland is a reflection of the strong mandate of the Swiss cantons. The existence of six of these cantons in a rather small spatial perimeter reinforces this fragmentation. Furthermore, inter-cantonal co-ordination mechanisms are weak. Few institutions that co-ordinate regional policy activities exist and they rarely cover the entire region or, if they do, they are only equipped with few competencies. Against this background, defining a coherent strategy for the biopharmaceuticals industry across the region is very difficult.

Informal arrangements

Some regions have developed informal mechanisms to permit them to organise policy formulation and delivery across a functional region. In the Eindhoven region, the initiatives to support economic development are carried out by collaborations like the Horizon Programme which was followed up by the Brainport Strategic Programme. In addition, a cross-border initiative, the Eindhoven-Leuven-Aachen triangle, was launched. From a regional economic development perspective, the city-region and the two largest municipalities of Eindhoven and Helmond are the most important and powerful actors in horizontal collaboration. However, this initiative sits alongside several other formal and informal mechanisms (such as the "Peaks in the Delta" regional economic planning programme at the national level and Brainport at the inter-municipal level) that crowd the administrative landscape.

The automotive sector spans many counties within Michigan and across into other states. A range of co-ordinating bodies have been set up by the counties with the support

Table 4.1. **Regional definitions and mandates in case study regions**

Region	Administrative region contains functional region?	Regional mandates for economic development
ICT		
Stockholm	Yes, with respect to the ICT cluster	• Regional level has a strategic role in planning and co-ordinating • Regional level weak • Limited funding and implementation possibilities • Municipalities have a strong position
Eindhoven	No, but different footprints are used by governments to correspond to the functional region. A formal government level, city-region (so called WGR+ region) has also been formed	• Regional level has a strategic role in planning and co-ordinating but limited funding • The operational work is carried out by regional economic development agencies and by increasingly important triple helix public-private partnerships • The city-region (21 municipalities) plays an important role in initiating horizontal collaboration
Ottawa	Yes, merger of political units to better map to functional region	• Regional level has a strategic role in planning and co-ordinating • Municipalities have a strong position, especially after the merger • Depending on the service or programme, the City of Ottawa partners with many private organisations
Recife	Yes	• Regional level has a strategic role in planning, co-ordinating and executing the policies • To bypass administrative burden, a not-for-profit association, defined as Social Organization (OS) under Brazilian law, carries out regional economic development within the ICT sector. It has both regulatory and financial authority • Generally, the municipal level is not involved in economic development
Automotive		
Västra Götaland	Yes, merger of political units to map to functional region	• Regional level has a strategic role in planning and co-ordinating • The regional level has a strong position in comparison with other regions in Sweden (it is an experimental regional structure combining multiple counties)
Turin	Yes	• Increased regionalisation • Loosely organised approach to economic development reflecting the informal nature of institutions
Detroit/ south-east Michigan	No, the automotive industry spans across several counties in the State of Michigan and Windsor (Canada)	• The state level has a strong mandate but a non-interventionist approach • Counties have relatively weak mandates • Informal arrangements to cover functional regions have been initiated; *e.g.*, SEMCOG a co-operation between ten counties in south-east Michigan
Shanghai	Yes, but auto clusters in close proximity in neighbouring provinces	• Shanghai municipality has provincial level status and a strong mandate and resources to support economic development
Biotech		
Stockholm	No, the biotech cluster spans across three counties in the greater Stockholm-Mälar region and there is no co-ordinating body	• Regional level has a strategic role in planning and co-ordinating • Regional level weak • Limited funding and implementation possibilities • Municipalities have a strong position
North-western Switzerland	No	• The cantons have a strong position (each canton and half-canton has its own constitution, parliament, government and courts) and considerable fiscal autonomy through cantonal taxes) • Small spatial perimeter of cantonal level a challenge for co-ordination: 26 Cantons for 7.5 million inhabitants and approximately 41 000 km^2
Montreal	Yes, merger of political units to better map functional region as well as co-ordinating body for greater Montreal region	• Regional level has a strategic role in planning and co-ordinating • Cluster-based action plans are being developed and implemented within a decentralised governance framework involving all economic stakeholders
Shanghai	Yes, biopharmaceuticals research-oriented cluster highly concentrated in one industrial park; production occurs in neighbouring province	• Shanghai municipality has provincial level status and a strong mandate and resources to support economic development

for the state authorities to help overcome co-ordination problems, both generally and with respect to key industries. One example is the south-east Michigan Council of Governments (SEMCOG). It was originally created to develop planning and co-ordination of business and policy initiatives among ten counties to improve business and regional economic performance across jurisdictional borders. More recently, it has focused most of its activities on workforce quality development initiatives. There are other initiatives as well that encompass several counties, in some cases more specialised or focused, such as Detroit Renaissance, an initiative between CEOs of leading companies which address the development needs of the region with a focus on human capital. Another example is Automation Alley, a technology cluster initiative that seeks to address some of the concerns of the automotive sector through retraining activities but also the development activities in emerging sectors using related technologies.

Merger of political units

One strategy used in the two Canadian metropolitan regions and in the Västra Götaland area was a merger or union of political units to better map the administrative boundaries to the economic functional area. In each case, the new administrative structure has been used as a framework for a regional development strategy.

The Montreal and Ottawa examples illustrate one of the most radical institutional reforms in OECD countries in the context of governance frameworks. Montreal and several surrounding towns were amalgamated to create a larger municipality. Ottawa also underwent an amalgamation. In 2001, the Ottawa-Carleton Regional municipality merged with six cities, four townships and one village to become one city with a single tier of administration. In the beginning, the process was quite controversial but it was reported that within a year of its implementation most stakeholders found it productive.

As part of the trend towards increased regionalisation in Sweden, in 1999 Västra Götaland was formed through the merger of the three counties. Those counties include Gothenburg and Bohus län, Älvsborg and Skaraborgs län. The region has taken over responsibilities from the national government for the planning of regional development. The region also was transferred some functions previously managed by the City of Gothenburg. The purpose of the merger was mainly to enhance the efficiency of operations and to provide a better platform for infrastructure planning. Västra Götaland has the same legal status as a county with responsibility for development and is, together with another county in south Sweden, Skåne, a pilot case for setting up new regions in Sweden.

Variations in regional mandates

A region's policy response is also bounded by the mandates of the municipal, regional and national levels, which varies considerably across national institutional frameworks. For example, the spatial impacts of national level funding for areas such as research and development, education and transport can play a very important role in the development of regional specialisation and define the margin of manoeuvre and level of ambition of regional strategies. Moreover, there are different rationales for different levels of government to support a particular regional specialisation, notably the extent and nature of positive economic spillovers from the cluster for the national economy (OECD, 2007a).

Among the case study regions, regional mandates vary from those with real tools for economic development to a limited planning role with minimal resources or authority. In fact, the municipal level led the "regional" support strategy in several cases. The ICT

clusters in Stockholm and Ottawa, for example, were all most actively supported by the municipal level. Shanghai is a special case having the powers of both a city and a province.

Strong regional mandate

In federal countries like the United States, Canada, Brazil and Switzerland, the regional level has considerable resources for economic development and a large degree of fiscal autonomy. However, in the case of the US, Canada and Brazil, that sub-national entity with a regional mandate is often of a much larger scale than a functional economic area. In others, the practical autonomy of the regions is also significant, such as in Italy since its administrative reform process. Shanghai, a municipality with provincial level status, also has a strong mandate and resources to support economic development.

The possible downside of a strong regional mandate is potentially unproductive competitive behaviour (even within the functional region) that undermines the possibility of developing clear strategies. In north-western Switzerland, the federal structure with each canton and half-canton having its own constitution, parliament, government and courts allots a large extent of fiscal jurisdiction to the cantons and the local authorities. This makes inter-cantonal co-ordination much more difficult.

Creation of regional planning bodies

In some cases, responsibility for implementing the strategy has been more or less entirely devolved to a quasi or non-governmental body. This is often the case, for example, where regional development agencies take on a broad mandate for agenda setting and programme delivery. In Recife, the State of Pernambuco is responsible for regional development but in order to avoid administrative burden, regional development is carried out by a not-for-profit civil association, defined as a Social Organization (OS) under Brazilian law. In this ICT example, Porto Digital has been vested with both regulatory and financial authority in order to carry out regional economic development activities. Generally municipal governments are not involved at a strategic level in shaping regional strategies. However, with respect to the ICT sector much informal energy comes from the university.

There are examples of regions that have successfully created themselves an entity with a more strategic, planning or co-ordination role but do not have the resources or direct responsibility for implementation. The Montreal Metropolitan Community (CMM) is an example where a regional level was created for planning purposes that does not exist in the institutional framework. Whereas municipalities or provincial agencies have executive powers, the CMM is a co-ordinating, planning and financing body for metropolitan-wide strategic functions. Contrary to a single-purpose metropolitan agency, it has a multi-sectoral focus including spatial planning, economic development, social housing, public transport and infrastructure, environment and culture. Its metropolitan-wide view enables policy coherence across municipal borders and helps to channel investments where they are considered most beneficial for the region as a whole. It receives some tax revenue, coming from municipal contributions and provincial grants, but has no taxing power. It does not act as a substitute for the players and decision makers currently working in this field (OECD, 2004b).

The city-region in Eindhoven is another example of a co-ordinating body. It was created by bringing together 21 municipalities who provide the funding. The city-region

facilitates planning in some key areas, such as regional development, traffic and transport, but also the environment and socio-economic conditions. Officially, the province has the mandate to invite municipalities to form a city-region.

In other cases, responsibility for regional planning coupled with a weak regional mandate has proven more problematic. For example, Swedish regions are responsible for developing economic development strategies. However the resources and ability to deliver the strategies rest with municipalities. These regional plans, known as Regional Growth Programmes (RTP) and Regional Development Programmes (RUP), aim broadly to sustain regional growth and better co-ordinate efforts of local actors through collaboration on strategic plans. However, municipality plans have no obligation to refer to these plans as compliance is carried out on a voluntary base. The County Administrative Boards and the county councils have a weak position relative to municipalities that hold substantive power in economic development. The overwhelming majority of the regional budgets are spent on health care, leaving little room for economic development activities. In the Stockholm area, the county RGPs do not play a key role as a co-ordination strategy with Stockholm City. In contrast, the RGP for Västra Götaland has achieved greater coherence across public and private actors for implementation, accenting the importance of the method for developing the strategy.

Developing the strategy: the importance of the process

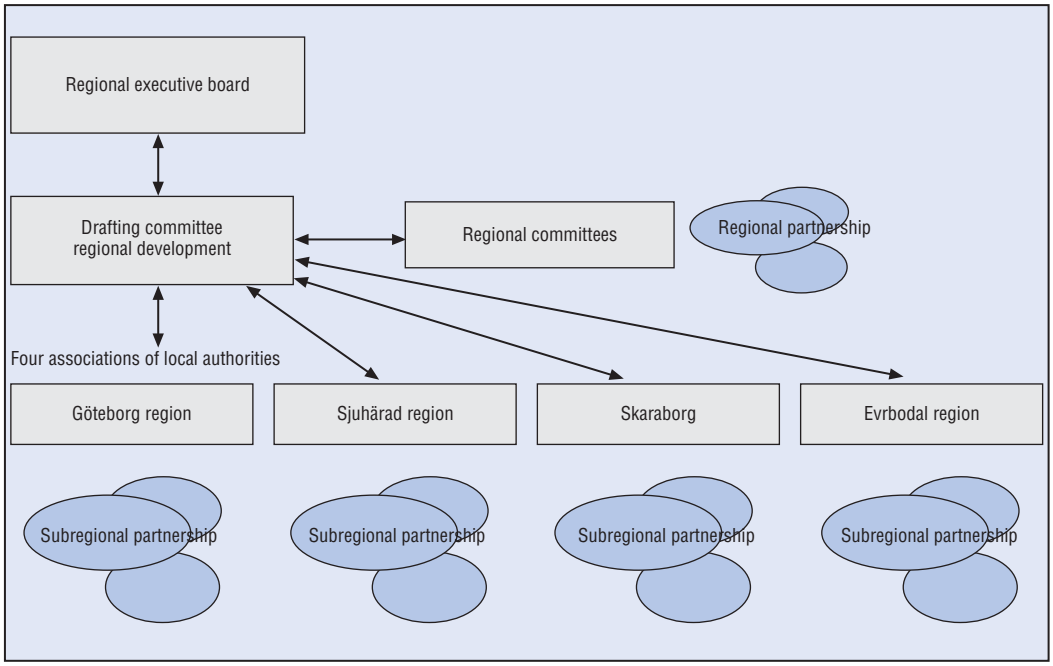
Mobilising public and private actors

Many public and private actors are ultimately responsible for economic development. Therefore, the ability to validate the strategy with those who will benefit or help implement it should not be underestimated. The process of developing the strategy itself serves several functions. In particular, active networking is important if the policy formulation process is to reflect real needs and be of value. In Montreal, for example, the large-scale project initiated by the Montreal Metropolitan Community to identify and define metropolitan industrial clusters has played a role in mobilizing a wide range of stakeholders that up until that point had not worked well with each other (for example, different municipalities preferred to support and market biotechnology industries located in their own areas). The creation of the action plan made it possible to begin the mobilisation process, which continued to a greater extent through work by the Life Sciences Committee.

By being mobilised behind an agreed strategy, stakeholders are more likely to co-operate when this is needed. A good example of this is the reaction of the Västra Götaland region in 2004 when General Motors announced that the production of medium-sized cars will take place in existing plants either in Germany or in Sweden. The fact that lead actors were already co-operating enabled the region to reorient its investment strategy to building intellectual infrastructure and sophisticated R&D programmes as a rapid and visible response to this potential crisis (Nutek, 2005). The overall strategy in the Västra Götaland region was developed in conjunction with the four regional associations of local authorities (sub-regions), with the assistance of a number of parties representing trade and industry, universities and colleges, and others as illustrated in Figure 4.1.

Increasingly, private actors are brought into the policy-making process to bring a broader perspective than the jurisdictional approach that often hampers consensus building. Ottawa, as is common in many North American cities, partners with numerous

Figure 4.1. **Västra Götaland regional model**



private actors. There are quasi-public economic development authorities and councils as well as The Ottawa Partnership (TOP), a public-private partnership that includes the mayor and a business leader as co-chairs. In that way economic development services can be carried out through actions performed by the municipality and through an independent development agency with which it is easier for private actors to work.

The process of developing such a strategy is contingent upon the institutions involved but also the cultural context. The case of Turin highlights the dual nature of institutions, formal and informal, in contrast with countries that have a highly formalised approach to regional strategies. In Recife, the Porto Digital Management Unit Board which manages the ICT cluster consists of 37% government representatives, 21% from the productive sector, 11% from universities, 16% from non-governmental organisations, and 16% from other groups of society. In that way, different stakeholders are involved in defining the strategy and put forward their views. They control the development by setting up objectives, goals and guidelines for the operation. In general, it is important that all stakeholders are involved in developing the strategy so that they all are committed to the strategy. In China, the public sector has a dominant role, making it difficult to develop at this stage public-private partnerships akin to those common in North America and some European countries.

Triggers for developing a regional strategy

The trigger for developing a regional strategy or related actions in several examples emanated from outside the region through an exogenous shock or a sector-specific crisis. The crises in the auto industry in Västra Götaland and in Detroit/south-east Michigan have led to initiatives to try to build a regional response. The impetus for Turin's regional economic strategy has also come in the wake of the near collapse of Fiat.

In other cases, the concern has been to revitalise or change the image of the region. In Ottawa, for example, the common goal of changing the city's image from being a sleepy government town to a dynamic high-tech hub rallied local stakeholders. There was an agreed upon need to change the image of the city from a political capital to one with other economic strengths, especially in light of public sector job losses. In Eindhoven, the initiative Brainport is an attempt to strengthen performance in global competitiveness and the reputation of the region as a top hot spot technology region and increase its visibility to the national government in comparison with other priority regions such as Rotterdam and Amsterdam. In Recife, the Porto Digital initiative was a response to the stagnation of the ICT sector with qualified labour leaving the region for jobs in the South.

National initiatives or policy shifts by the national government have also led to regions developing strategies, partly to enable them to access funding associated with a new policy focus. In China, plans are required at all levels of government. In Sweden, regional strategies are mandated by the national government. Furthermore, a programme of the Swedish Governmental Agency for Innovation Systems, VINNOVA, required that in the context of a programme call for proposals, the applicant cluster offers a clear picture of regional development initiatives. Applicants from both the regions of Stockholm and Västra Götaland were both rejected in the first round of funding applications. An important reason for unsuccessful applications in both regions was the lack of clear picture of regional development priorities. This event also served as a trigger for Västra Götaland to build consensus to access greater resources.

Nature of regional strategies

Overall strategic orientation

The aim of a regional strategy is ultimately to synchronise the supply of public goods and services to support firms, individually and collectively, and the business environment generally. The most difficult challenge is that the real-time needs of the private sector often evolve more quickly than policy can address. The conceptualisation, formulation and implementation of successful regional economic strategies depend on the ability of regional stakeholders to understand the transformations that affect the regional economy. If it is true that regional economic success depends on the learning abilities of social and economic systems, it is also true that such success depends in a fundamental sense on learning government systems at regional and national levels.

Goals of these regional strategies may cover several important themes. One is the degree of alignment of education and research institutions with the development requirements of different firm and cluster needs. Another is the degree of correspondence between technological development and economic contribution. Other factors that have an impact include infrastructure support, advanced business services, fiscal incentives, world-class educational and research facilities, and quality of life, which are intended not only to attract but also keep investment by embedding it in the regional economy. Although there is considerable variation along these issues in the regions considered here, they generally illustrate the importance of a synchronised enabling framework for the competitiveness of a region and its cluster.

More than spatial planning, a regional strategy can be like a foresight exercise that includes an understanding of the region's positioning and where it is headed. The nature of the challenges suggests that a clear region-level vision is an important step towards

rethinking a region's economic direction. Case study regions ranged from having no overall regional strategy, or at least not one that is clear, to having a plan with clear prioritisation of public support for particular sectors or clusters (Table 4.2).

Many of the regions have developed an overall vision to guide the economic development work. These vision documents are usually not concrete action plans but set the overall scene for economic development. The vision is then taken forward either by the public sector alone or in conjunction with private actors.

In Ottawa, economic development activities are guided by the Ottawa Vision 20/20 and the City Corporate Plan. The Ottawa Vision 20/20 is a long-term strategy for positioning Ottawa for innovation, competitiveness and prosperity and it lays out policies for key Ottawa business markets, including the export sector. It has been developed by the City of Ottawa in co-operation with stakeholders from the business, academia and public sector. While ICT is noted to be a main driver of the city's economy, the focus is on more general competitiveness framework conditions such as skilled labour, the general business climate, infrastructure and the quality of life.

Region Västra Götaland has developed Vision Västra Götaland, an overall framework to organise regional actions in order to enhance the region's appeal as a place to live and work and specifies long-term objectives. In terms of economic policy intervention the Vision has five focus areas. These are: sustainable trade and industry; a leading position in competence and knowledge development; the development of infrastructure and high standard communications; the cultural life of the region; and health. This vision is closely

Table 4.2. **Regional strategies of case study regions**

Region	Overall regional strategy	Targeting sectors
ICT		
Stockholm	Regional Growth Programme – RGP (key strategic document [county level] + the City of Stockholm Master Plan [local level])	Yes, but the ICT sector is not prioritised
Eindhoven	Yes, Brainport Navigator 2013. Beyond Lisbon!	Not explicitly but different plans and programmes support high-tech sectors
Ottawa	Yes, Ottawa Vision 20/20 City Corporate Plan	Not explicitly, but support high-tech sectors by enhancing framework conditions
Recife	No	Yes, the Porto Digital initiative targets the ICT sector
Automotive		
Västra Götaland	Yes, Vision Västra Götaland Regional Growth Programme – RGP (key strategic document at the county level)	Yes, nine clusters are prioritised as well as cross-sector initiatives between these clusters
Turin	No	Yes, regional government established "platforms" for firms in the automotive, ICT, aeronautics and transportation sectors
Detroit/south-east Michigan	No	Not explicitly, but many initiatives are targeted to the automotive sector
Shanghai	Yes	Yes, auto is a "pillar industry" for the region
Biotech		
Stockholm	RTP key strategic document (county level) + the City of Stockholm Master Plan (local level)	Yes
North-western Switzerland	No	Not explicitly; but several cantonal policies have a sector focus mainly on traditional sectors
Montreal	Yes, the CMM Council economic development plan	Yes, 15 clusters identified
Shanghai	Yes	Yes, biotech is a high priority sector in science and technology plans

related to the Regional Growth Programme, which is an operational plan that responds to a mandate from the national government.

In a couple of regions, the regional strategy has been championed by a local leader. It is clear that certain individuals have played a key role in developing the ICT cluster in Recife and most people would argue that the cluster would not have developed with the same speed without these people. Many of them have a background either within the university or are senior government officials with close connections and broad networks within the government. In Ottawa, certain key individuals were mentioned as important for the development of the ICT cluster, especially certain entrepreneurs that built up and started several companies.

Planning documents continue to be key guiding documents for public action in all fields in China. The 11th Five-Year Plan, which is the most influential blueprint guiding the country's social and economic development, including the broad orientations for S&T development. Below the national level, provinces, cities and counties develop their own local social and economic development and science and technology development plans, in line with the general framework set at the national level. For Shanghai, this means that the planning documents offer guiding principles and concrete actions for a regional strategy.

Targeting sectors and clusters

While explicit sector-specific industrial support is uncommon, most economic strategies still target specific sectors in some way, usually through a cluster initiative. While they may have a sector-neutral approach in their set up, when focusing on a region's key strengths certain sectors (and their geographical locations) will naturally be highlighted. Most of the strategies target traditional strengths as well as a couple of new or emerging sectors. The forms of support channelled to clusters tend to be through cluster initiatives or some form of collective services for the actors in the cluster.

Rationale and selection for support

There are a number of legitimate rationales for supporting a specific sector or cluster in the regional economic strategy as illustrated by the case studies. Employment creation and wealth creation are the two primary goals of these policies but they are not always synonymous. As production is increasingly outsourced, many of the niches in global production networks remaining in regions employ few people. Some sectors or clusters may be deemed in need of assistance due to poor growth. Sectors on the decline shedding employment are a political challenge for any region that these strategies seek to address. Other sectors may be more enabling, as they are integral to others, such as ICT. In terms of R&D investment, often the rationale is to target not the traditional sectors but those on the new frontier that are likely to be critical for competitiveness in ten years. They may include nanotechnology and innovation in healthcare or specific competitive technology platforms, ranging from hydrogen energy to intelligent systems.

Stockholm county's regional planning does prioritise clusters, but not necessarily the largest. Even though ICT is an important sector in terms of value added and employment for Stockholm, the county did not prioritise the sector for support. This is in part due to the fact that the City of Stockholm, with significantly more resources, supports the Kista science park where many cluster actors are located. Therefore while ICT is important to the region, it was deemed that the cluster didn't need regional support as much as others do.

In Västra Götaland, one main objective within the regional strategy is to promote an innovative economy. Cluster development is a key strategy to achieve this goal, together with strategies to promote entrepreneurship and specific initiatives to support the development of SMEs. Nine clusters are prioritised as well as cross-sector initiatives between these clusters. These are life science and health care, automotive, ICT, food, petrochemicals, textile, wood and creative industries.

Montreal's CMM Council economic plan includes a list of clusters developed through a comprehensive cluster audit. The multi-stage cluster audit involved a mapping, including an assessment of high potential niches, economic and institutional elements, relationships among actors and strategic potential. Ultimately 15 clusters were selected with the support of an expert technical committee and regional stakeholders, grouped under four types of clusters each with a separate rationale for support:

1. *Competitive clusters* (aerospace, life sciences, information technologies and textiles/clothing). With the exception of the textiles, these clusters are all part of the new economy. As for the textile industry, it is a major source of jobs in Montreal and could complement many other industries if it quickly shifted to technical textiles. All of these clusters already include world leaders in their respective fields.
2. *Visibility clusters* (culture, tourism, services) serve to market the metropolitan area by supporting more generally the city's development efforts. These strategic clusters serve to ensure the overall quality of life that nurtures the dynamics of innovation and make the metropolitan area more attractive.
3. *Emerging technology clusters* (nanotechnologies, advanced materials, environmental technologies) involve technologies with tremendous growth potential over the long term. They have fewer members than other clusters because they rely primarily on sustained R&D efforts and some of their applications are horizontal.
4. *Manufacturing clusters* (energy, biofood, petrochemicals and plastics, metallurgy, and pulp and paper) involve a wide variety of industrial segments. Although associated with the old economy as opposed to the new, they still offer excellent growth potential in many markets and generate a high number of jobs.

Support for clusters existed in several regions but was not part of an overarching economic development strategy. In Turin, the sectors are supported in the context of research and innovation platforms but these are more loosely co-ordinated actions rather than an overall strategic framework. In Recife, cluster support as a specific initiative only exists for the ICT cluster known as Porto Digital. However, the initiative has been successful and the State of Pernambuco is now trying to replicate the cluster strategy in other sectors and regions. The policy has worked as a tool for mobilisation and allocation of resources to an emerging cluster with backing by all actors in Recife and has encouraged greater university-industry linkages and knowledge spillovers in general. While Ottawa's city vision and plan do not specifically target sectors or clusters, there are a number of initiatives by various public and public-private actors that serve the ICT sector. In the province of North Brabant (Eindhoven), public authorities are focusing their efforts on more general strategic actions plans and programmes. However, the city-region of Eindhoven has put much effort in strengthening its profile as an ICT region and in branding it world-wide through these different plans and programmes.

The north western Switzerland region does not actively pursue an approach of supporting Life Sciences using targeted business development measures. Rather, the

cantons in the core area of north western Switzerland limit their activities to creating a framework of laws and regulations that is conducive to innovative R&D, entrepreneurial initiative, firm creation and spin-offs in the area of Life Sciences. However, since most of the cantons have a general objective of increasing the attractiveness of the canton, the present economic structures (such as life sciences and precision mechanics) and strong sectors influence the business development and acquisition activities.

There is always a challenge for the public sector to ensure sufficient private sector engagement in the context of cluster initiatives. In the case study examples there are common strategies for sharing roles between the public and private sector. This role-sharing usually concerns membership on the oversight bodies for the initiative. Nevertheless, there are some examples where the public sector is the real driver of the initiative and in other cases it is the private sector, albeit there may also be strong public support (see Table 4.3).

Risks associated with targeting regional specialisations and clusters

Regional governments struggle with how to effectively embed key firms and industries in the region while managing exposure to economic shocks to the extent possible. Policy makers are not necessarily in the best position to anticipate business risks, especially given the rapid pace of change.

There is a risk of wasting public resources in support of "wishful thinking" clusters. The appeal of high-growth industries can lead to a cluster approach that attempts, often unrealistically, to generate critical mass in fields such as life sciences and ICT in which competition is particularly fierce. The public investment requirements to start a cluster from scratch are very high and not all regions share the same economic structures and institutional settings in order to be competitive. Absorptive capacity for new technologies is another important element. These considerations raise the question of whether clusters can be created and, if so, at what cost.

There are also risks related to the cluster's structure. Regional economies based on small firms working in the same or related sectors can be vulnerable to market shocks that undermine simultaneously all firms in the cluster. Hub and spoke, platform and state industry clusters can also be seen as vulnerable if the core firm leaves or downsizes. Therefore, efforts to embed such core firms are at the heart of several regional strategies.

Another form of risk is that firms in a cluster may become too inward looking or rigid. This results in what are termed lock-in effects, whereby the major investments to support specific sectors or clusters make it difficult to adjust strategies to new circumstances later because the cluster is less open to adaptation (Andersson, *et al.*, 2004). However this last point is clearly the subject of debate, as other theories identify clusters as a way to generate greater rivalry and complementarities which spur innovation, not complacency.

The emergence of paradigm-shifting new products or technologies is rare, and betting too much on a disruptive technology is a risk, but so is not anticipating the potential of such a technology. There have been many examples where regions have shaped their economic future around such technological innovations, but these are exceptions to the rule. The most obvious example is perhaps the emergence of Finland's mobile telephone cluster. Another example is the growth of an advanced ICT cluster around the RIM facilities in Waterloo, Canada where the Blackberry was created. At the same time, new technologies can bring risks for established clusters. The R&D effort to develop alternative fuels could,

Table 4.3. **Public *versus* private role in cluster initiatives of case study regions**

	Public sector role	Private sector role	Driver: public vs. private
ICT			
Recife	40% of Porto Digital Board representation, funding, real estate	Board representation	Public
Ottawa	Co-ordinate across and support private cluster initiatives	Manage different cluster initiatives	Private but strong public support
Kista	Mayor member of Electrum Foundation that oversees the Kista Science City company; support incubator initiatives located in the Science City; Lead in terms of vision of a science city concept	Board members of Foundation, real estate privately managed, minimal engagement in the Science City concept	Public (Science City) Private (cluster orientation)
Eindhoven	Brainport for regional development (public-private foundation with local public funding)	Board of Brainport, Management of High Tech Campus Eindhoven research park, Point One Cluster initiative for embedded systems (privately run with public co-financing)	Private but strong public support
Automotive			
Turin	Fund a platform that supports the automotive sector	No active private sector involvement	Public
Västra Götaland	Cluster facilitation, channelling of funding from national and regional programmes	In the "Innovative co-operation platforms" (Lindholmen Science Park in Gothenburg and Innovatum In Trollhättan), the automotive industry participates as well as other related industries, such as ICT companies	Public
Detroit/south-east Michigan	Initiated several partnerships such as Automation Alley, Detroit Renaissance	Involves private sector actors	Public
Shanghai	Zoning policies for co-location and regulation for joint ventures; different technology-based platforms	Participate	Public
Biotech			
Montreal	Organisation of support studies, facilitation of cluster "table" (steering committee)	Private sector leads steering committee, leads strategic decision making and resource allocation	Private but strong public support
North-western Switzerland	BioValley, MetroBasel initiative, Bern Cluster Policy	Involves private sector actors	Public funding and support essential
Stockholm	Many of the cluster initiatives are driven by the public sector	SMEs play an active role in some of the cluster initiatives	Mixed
Shanghai	Zoning policies for co-location; different technology-based platforms	Participate	Public

in theory, reshape the auto industry over time. The main research and testing facilities for fuel cell technologies are in California and in the Vancouver region, not in traditional car producing regions. And the main cluster participants are often from other sectors such as energy generation rather than car makers.

Economic strategies targeting specific sectors have been criticised in several regions. In Turin the debate during the past ten years has focused on whether the region should place strategic emphasis on new or traditional sectors. The emphasis on new sectors originally stressed the importance of ICT, and more recently other leading economic sectors such as health sciences. It was in this context that the *Torino Wireless* initiative was launched. The key objective was to increase ICT intensity in the traditional sectors of the regional economy while fostering entrepreneurship in new ones. However, the initiative has not been supported by other measures to enhance innovation capacity in traditional

sectors or measures to include key stakeholders and especially the SMEs. As a result, the initiative has met with criticism that it was too late.

Linking with national level strategies and resources

Spatial impacts of national policies

Many of the instruments and resources that would be important for a cluster, such as R&D funds, are offered by a higher level of government. Therefore, these regional strategies in several cases seek to tap into these greater regional or national resources. For example, the Province of Quebec receives a disproportionate share of national resources to support the biotech industry. Nearly 50% of Canadian health research funding and most of the research activities are carried out in Montreal. Quebec represents 23% of Canada's population, but accounts for 68% of Canadian prescription drug patents, 42% of R&D pharmaceutical investments, and 41% of R&D biotechnology investments. Most of these activities are located in the Montreal region.

Being a capital city also offers regional advantages for national resources because many R&D centres may be located there. It is for example an advantage in Ottawa to be close to the National Research Centre (NRC) as well as the Communications Research Council (CRC). NRC has several joint projects with private industry and has set up a business development organisation with the purpose of finding and establishing liaisons/alliances with private companies. These firms may be interested in utilising innovations done within the NRC or in setting up joint ventures for the commercialisations of patents and innovations. By actively marketing such findings, the NRC is not only contributing to financial funding of its innovative operations, it is also contributing to establishing new companies. CRC supports decision-making policies and provides expertise to programmes with the aim to transfer the outcome of its R&D projects to firms for development. Both organisations are actively promoting business development and technology transfer with and to private companies or by enabling start-ups.

National level strategic priorities and cluster policies

In many countries, the national level targets certain sectors through industrial or science policy that reinforce the region's strategy. In some cases, regions may even seek to map their support to these priority clusters to access greater funding or other forms of support. As part of national industrial policy in the context of the Innovative Sweden strategy, Sweden has selected six key sectors for sectoral strategy plans to be developed through national dialogues. The three sectors studied in this report are part of this priority list. In the Netherlands, national priority areas for research include ICT and nanotechnology, areas of strength for the Eindhoven region. Within the automotive sector, the role of the national level ranges from no intervention to subsidies.

Many national level cluster policies actively involve regional level public actors in their approach. In fact, many require the support of regions in the selection and/or funding of particular cluster initiatives. The national level may manage the call for proposals but require that the region support the project in principal or even in terms of co-funding of projects. In some cases, the national level may allocate funds and delegate responsibility for actually managing the programme (OECD, 2007a).

National level programmes were most notable in Sweden, and to a lesser degree the Netherlands. The national level Dutch programme to support key innovation areas,

including nanotechnologies and semiconductors, is important to Eindhoven even if it does not involve the regional level directly. Point One's strategy is to co-finance activities prioritised by a private-sector led cluster initiative composed of both large firms and SME representatives in the area of embedded systems. One of the strategies of the programme includes strengthening the quality of the local supplier network to embed several of the important large firms present in the area.

In the past, the cluster concept has not been prioritised or discussed at the national level in Switzerland. Many consider that Switzerland does not have the critical mass and only has capacity for two to three clusters. However, this has changed and the national government is today in an exploratory phase regarding cluster policies, considering whether to adopt one or to leave it to up to the regional level to decide. The role of clusters has increased partly due to a shift in public support from lagging regions to leading regions, with most industries clustered around leading cities.

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PART II

Summaries of Region-sector Case Studies

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Can OECD Regions Complete in Global Industries?

PART II

Chapter 5

Regional Case Studies in the Automotive Sector [1]

This chapter looks at the evolution of the automotive industry and the impacts that changes in the industry are having on four car-producing regions. In each case, the regions are struggling with the impact of restructuring of the global car industry but also striving to build on the technological and innovative capacities that the regions have acquired over time as leaders in a dynamic technology-driven industry.

Global outlook

For decades, the automotive industry has grappled with the task of reconciling the conflicting requirements for economies of scale – and hence standardised output – and growing market demands for product diversity. The challenge facing the industry is that recent attempts to achieve standardisation – such as platforms, modules, and "world" cars – have foundered on the rocks of market demands for difference and mass customisation. In all sorts of ways these pressures for diversity are increasing exponentially.

At the beginning of the 21st century we find a car industry that is in the middle of globalisation and delocalisation into emerging markets such as China, India and smaller motorising markets such as Indonesia not far behind. Patterns of production capacity are somewhat lagging behind this process. The major production locations (Table 5.1) broadly reflect the fundamental changes in automotive markets, with the notable exception of Japan, which has long had a net structural bias whereby production exceeds domestic demand, with the balance accounted for by exports. At the same time, the industry is in the throws of a financial crisis affecting some of its largest, most established players. In addition, the negative environmental and social impact of automobility is increasingly being questioned. As a result, the next few decades could see the emergence of a very different automotive industry with its centre of gravity and its major players moving eastwards to emerging economies and away from the traditional decision-making centres. Toyota has emerged as the world's leading car manufacturer, perhaps to be joined by other Asian players in the foreseeable future. The American model that has dominated mass car production during most of the 20th century could give way to a new Asian model with unpredictable consequences for the global automotive industry.

Car production today is still dominated by the traditional "triad" regions of western Europe, North America and Japan-Korea. Table 5.1 illustrates the recent history of vehicle production in the different producing regions, which clearly shows the Asian Pacific region as that with the strongest growth.

Table 5.1. **Global production by region (In thousands, all vehicles)**

Region	2000	2001	2002	2003	2004
North America	17 658	15 814	16 713	16 215	16 224
Western Europe	17 165	17 797	17 294	17 387	17 722
E & C Europe	2 647	2 658	2 660	2 726	3 146
Asian Pacific	17 945	17 665	20 300	22 299	24 322
Japan	10 140	9 777	10 257	10 286	10 511
China	2 008	2 304	3 251	4 443	5 070
South America	2 010	2 047	1 999	2 036	2 531
Total	57 427	55 963	58 968	60 665	63 948

Source: Ward's Automotive Yearbook, various years.

Over the last ten years or so, a number of trends in vehicle production have become evident. One of these is a general reduction in the capacity of a single assembly plant considered viable for profitable production. This is one attempt to meet the outcome of diversity, through shorter production runs more sharply targeted to market niches. This is reflected in the introduction of more flexible production systems and platform strategies. In addition, we have witnessed the closure of much older capacity in Japan (especially Nissan plants after the link up with Renault), the US, and Europe with some improvement in capacity utilisation as a result. The opening of new high-volume plants in the United States (*e.g.*, Mercedes, BMW) and the European Union (BMW, Toyota, PSA-Toyota) is also significant. The US plants of Mercedes, BMW and Honda have become a significant source of exports from the US to the EU. These new plant locations reflect the general phenomenon of inter-market penetration by rival vehicle manufacturers and the advantages of market proximity being balanced against those of centralised manufacturing.

A number of new or refurbished low-volume and high-value added plants making specialist cars have also appeared in Europe; *e.g.*, Rolls-Royce, Maserati, Aston Martin, Porsche and Bentley. A high proportion of output from these factories is exported, with over half typically going to North America and growing numbers to Asia, although actual volumes are small. In addition, the much-anticipated expansion in new capacity in central and eastern Europe is finally materialising, much of it coming into production over the next few years. Finally, there are large investments in emerging markets in the Asian-Pacific region, in particular China and India.

Car making today: the automotive industry value chain

A modern car plant is typically part of a system that remains wedded to the notion of serial production in high volume of essentially identical or nearly identical vehicles. It consists of a press shop, where sheet steel is pressed into panels, a body shop where these panels are welded into a combined body-chassis unit – the monocoque or unibody – a paint plant, where this unit is painted and protected against corrosion, and a two-stage assembly process, where the painted body receives its mechanical, electric/electronic, glass, and interior trim components. In terms of investment costs, the elements needed to make the all-steel body, together with investments in engine manufacturing – the latter normally in separate dedicated plants – dominate modern car manufacturing. The investment in all-steel body technology and internal combustion engines is very high and much of it needs to be sustained at high levels as the regular model changes introduced by the car industry bring with them high investments in new body-tooling on a regular basis. Engines can be applied more widely across different models and can be specified to last several model cycles, although tightening emissions regulations have meant a shortening of model cycles even in this area.

Actual plant sizes vary widely from the very small (Morgan, Lotus, Ferrari) where per-model output is measured in hundreds or low thousands, through low-volume plants producing variants and derivatives (Karmann, Valmet, Pininfarina, Magna-Steyr) where output may be in the range 30 000 to 100 000 units per annum for a range of models, all the way up to huge plants like Volkswagen's Wolfsburg plant or Hyundai's Ulsan facility, where output can be over 800 000 units per annum. In Europe, if the very small producers and plants with an output under 100 000 units are excluded, production in 2001 amounted to 11.12 million units from 41 plants, with average plant output of 271 000.

As long as markets demanded basic automobility and were prepared to accept limited variety, this mass production system worked well, benefiting from true economies of scale. However, as market saturation set in, car buyers began to demand greater model variety. More recently, regulatory pressures have added to the proliferation of variety, with more fuel and drivetrain types emerging. As a result, per model volumes have been falling and economies of scale are being eroded in many cases. A tension between the demands of the market and the demands of the mass production system has developed, which is still growing today. In Europe it is now estimated that as a result of these trends some 60-70% of models offered in the market are essentially unprofitable. These are cross-subsidised by the remaining models that are made in sufficient volume or can attract a sufficient margin to go beyond break-even and thereby retain some profitability. However, this does allow manufacturers to offer a full model range and thus for their dealers to sell an attractive range of products. It does mean that, even in a good year, the most successful players in the car industry enjoy returns on sales of less than 10%, a figure that would be unacceptable to many other consumer product sectors. Car dealers in developed markets work on even lower margins for new car sales, instead relying on repair, service and parts sales.

The automotive industry value chain is pivoted around the dominating presence of the vehicle manufacturers. Despite rationalisation through mergers and acquisitions, the supply side of materials and components remains much more fragmented. The attempt by Anglo-Indian steelmaker Mittal to acquire the largest European steelmaker, and the political repercussions of this attempt, are a stark reminder of the scope for further consolidation across much of the components and material supply side – as well as the many obstacles in the way of such a process.

The old pattern whereby certain suppliers were closely aligned to specific vehicle manufacturers has been undermined though not entirely disappeared. In Japan, this pattern was often shown in the form of "tiered" *keiretsu* groupings of companies, with the vehicle manufacturer on the top of a pyramid of tier one, two and three suppliers. The Detroit region demonstrates the dense supply linkages that develop with the vehicle manufacturers at the centre of a complex system. Vehicle manufacturers have largely adopted "preferred supplier" strategies that have reduced the number of suppliers with whom they have direct contact. However, the desire for lower managerial costs has been somewhat offset by the desire to retain some control over suppliers. Moreover, globalisation and M&A activity by the vehicle manufacturers create turbulence in the supply base, disrupting old production and location linkages while introducing new ones.

On the other side of this value chain are the independent franchised dealerships, again largely characterised by relatively small companies dominated by the vehicle manufacturers. In comparison with other products such as ICT equipment or pharmaceuticals, distribution of finished vehicles remains relatively slow, unresponsive and expensive. Some 8 to 9 million new and used cars are shipped around the world each year, requiring dedicated vessels and port facilities. Inland car distribution is dominated by the use of trucks, though there are also significant rail facilities particularly in Europe. While some larger retail groups are emerging in the United States, the United Kingdom and parts of Europe, this is another area ripe for further restructuring. Slowly, the industry in established markets is tending towards large, multi-function, franchise and multi-location dealer groups. Industry estimates indicate that only some 3% of the total lifetime profit generated by a vehicle is attributable to manufacturing, with much of the remainder accounted for by items such as insurance, finance, maintenance, repair, and so forth. It is

not widely appreciated that in mature markets the value of used car sales is as large as that for new cars. In mature markets it is often corporate buyers that dominate the market for new cars, with all manner of consequences. In addition, the ownership and use of cars generates a huge economic impact through employment in a wide range of activities.

Markets

As noted above, the major markets have long been North America, Europe and Japan. Regulatory and other differences have tended to restrain the scope for product homogenisation between these regions, or indeed with emerging markets in eastern Europe, South America, Africa, India, China and other Asian countries. While efforts at environmental and economic regulatory harmonisation have made some progress, much still needs to be done until there is a genuine world "single market" for cars.

It is well known that traditionally North Americans have favoured larger cars in relation to other markets. In recent years this been translated into a higher proportion of light trucks, which include SUVs, pick-ups and minivans (often known as people carriers in Europe) that now account for around half of all new private sales. This has restricted US manufacturers' ability to export from North America to other markets. Similarly, Korean and Japanese consumers have strongly favoured locally produced cars, making import penetration difficult. In Australia, a unique full-size segment continues to exist which is served exclusively by two local producers, GM-Holden, and Ford, with its Falcon range. Other features illustrative of difference on a global scale include:

- Diesel engine cars in Europe;
- *Kei*-class ("midget") cars in Japan;
- Near-zero import penetration in South Korea and a mere 5% in Japan;
- Preference for saloon-style small cars in India and many other developing markets;
- Preference for hatchback-style cars in Europe;
- Absence of minicars in China (although there are new government incentives to encourage them);
- Limited market for cars of 2.0-litre engine or more in Italy due to taxation.

Such differences become accentuated when one considers that other emerging markets are adopting motorisation on a large scale, notably India and China, which militates against global car concepts designed to capture ever-greater economies of scale. In addition, more subtle and nebulous differences endure with respect to how vehicles handle on the road, to textures, colours, materials – even with air conditioning. For example, the US market prefers a blast of cold air, while Europe tends to opt for less intrusive "climate control" systems. On the other hand, while leather interiors are valued in the EU and US, they are not appreciated by Japanese buyers.

In addition, fragmentation has been evident as a result of platform strategies whereby each platform yields an increased number of models, body styles and variants. While in the 1960s a company like VW could prosper with a limited number of variants built on a Beetle platform, today all companies need a range of product offerings covering a growing number of segments, sub-segments and niches. During the 1950s and 1960s, people were looking for basic automobility, but from the 1950s onwards in the United States and the 1970s onwards in western Europe, people began to expect more individual differentiation. New segments and niches emerge all the time, while others rise and fall. Even within a

single segment a range of body styles now has to be offered on each platform, even though sales of some of these variants are low.

Product life cycles have been diminishing over many years in the industry, for specialist products as well as for high-volume products. Even "best in class" models can expect a period of only two or three years at best to enjoy the leadership position.

Markets are also becoming fragmented as different technologies are deployed, in response mainly to environmental and regulatory pressures. Most notable in this respect is the emergence of the petrol-electric hybrid pioneered by Honda and Toyota, but this in all likelihood is just a glimpse of things to come. In the future there will be an even greater choice of fuels (including bi-fuel and even tri-fuel options), engine type, body technology, and drivetrain. This may or may not include hydrogen-powered and fuel cell vehicles. Flex-fuel vehicles accepting any mix of petrol with ethanol from 0-100% are already sold in Brazil.

A key issue in many emerging markets has become the health impact of vehicles. The World Health Organisation has already drawn attention to the disproportionate negative consequences for death and injury arising from car and other vehicle use in markets that, for various reasons, have not adapted well to motorisation. In Ethiopia, for example, more people are killed by traffic accidents than by war or famine.

At the other end of the scale, there is much debate as to whether there is scope for a "bargain" or "value" brand in established and emerging markets. Tata for example has announced its intention to launch the 1 Lakh car (approximately USD 2 500) in India, to bring mass motorisation to the burgeoning middle class of the country. This is not necessarily the adoption of "motoring-lite" by emerging markets, in the form of cars stripped of content, but the design of products appropriate to those markets. For example, standards of maintenance and aftercare may be lower in many emerging markets, hence the need for cars that are rugged, robust, simple and within the capability of owners to repair and support. This also explains the long persistence of the traditional Lada in Russia.

In addition, some emerging markets already have a strong tradition in types of motorisation that fall outside traditional Western concepts, most notably of course the motorised rickshaw found in many Asian markets. In countries like India and China, unit sales of such vehicles still match those of "normal" cars. Long seen as indicative of technological backwardness, they are now being seen as indicative of "appropriate" and market-balanced technology.

Markets undergoing motorisation are usually thought of in terms of the "S-curve" of development. Car sales start slowly at first, accelerate over a period of time once a threshold level of per capita income is surpassed, and eventually level off. In addition, in many emerging markets the composition of the markets also changes over time. Initially trucks and motorbikes dominate, whereby simple flatbed trucks are used to transport everything from goods to humans. In a next phase a consumer society begins to take off and light commercial vehicles appear to distribute consumer goods. In this phase bus use also increases as consumers now have the wealth to travel and explore their own country. These eventually give way to a higher proportion of sales of passenger cars and the car market takes off, although high population densities have prevented Asian countries – such as Japan or Singapore – from achieving the levels of motorisation of other developed countries.

Brands

During the 1990s, much of the market began to focus on branding of technological differentiation. As a result, new issues have arisen such as brand stretch – either downwards (Mercedes A Class, BMW 1-Series), upwards (VW Phaeton) or sideways (Porsche Cayenne) – and potential confusion created by multi-brand constellations for broader market coverage. As a result, internal cannibalism (one brand taking sales from another held within the same parent group) has become common, as for example between SEAT/Skoda and VW on the one hand and VW and Audi on the other, squeezing the VW brand from both sides.

The market has also been affected by changes in demographics which introduce permanent changes. These include ageing populations in Europe and Japan, rising divorce rates and hence more and smaller households in Europe, Oceania and North America, as well as different market requirements from extended families in Asia to single-child families in China. New brands have been introduced, such as the Scion brand by Toyota or the Saturn brand by GM (both in the United States), in an attempt to capture a larger share of the youth market.

On the other hand, there has also been marked growth in the highest priced market segments catering to the new class of superrich with new brands being launched such as Pagani, Koenigsegg, or Ascari, the revival of previously extinct or moribund brands, such as Maybach, Bugatti or Spyker and the expansion of more established brands such as Rolls-Royce, Bentley or Ferrari.

Recent years have witnessed the emergence of a growing segment of cars costing over USD 200 000. Such cars are bought by a group of people far removed from the ordinary car buyer. Typical buyers in this segment are successful in the real world and arguably less brand-loyal, so it is possible in this segment for new entrants to be successful. While some buyers may just want a Ferrari, many want a particular set of individual product characteristics and if those are delivered more successfully by a Pagani Zonda, they will choose one of these. The fact that other people have not heard of such a new brand is of little relevance to these buyers, and in fact can be an incentive for a car purchase.

The hope for economies of scale comes from market expansion, mostly outside the traditional locations. The pressure for diversity comes from:

- Emergent new technologies and a splintering of regulatory pressures, meaning that "one best way" is unlikely to become dominant in the near future;
- Emergent new markets, with often rather different requirements from the established markets;
- Fragmentation of demand, brand disloyalty, changing demographics, changing status of the car and of motorised personal transportation in the light of market saturation.

The anatomy of the automotive industry

The current structure of the global automotive industry does not provide the conditions for the emergence of a single way of delivering products. Diversity arises from attempts to resolve the basic contradictory pressures the industry faces in terms of scale and diversity. While responses have not been uniform, broad trends are discernible. Vitally, many of the strategic responses outlined below have failed to achieve the results hoped for – thereby providing the basis for the contention that alternative business models and strategies may emerge in the future.

In the face of market fragmentation and stagnation, vehicle manufacturers have adopted a spectrum of responses to cope with, circumvent or deflect the challenges to their core business. The vehicle manufacturers remain locked into the economies of scale resulting from their chosen technologies. At the same time they have sought to reduce capital intensity throughout the business. A growing challenge is how to manage legacy costs in the established production locations: in North America both GM and Ford have struggled with the financial burden of pension and healthcare costs; in Europe companies like VW have met with labour and political resistance to the need to reduce overall employment and close plants.

Over the period since 1990 in particular there have been several interlocked key strategies including:

- Mergers, acquisition and consolidation;
- Multiple brand constellations;
- Platforms and architectures;
- Vertical disintegration and purchasing strategies;
- Technology enhancement.

Manufacturers have to reconcile short-term performance against long-term viability. Suppliers face similar problems, particularly in trying to create robust business portfolios of technical competence and geographic reach – and there have been several high-profile crises as a result.

Mergers, acquisitions and consolidation

In the 1990s, the global automotive industry went through a major round of consolidation under which very large corporate concerns were created. This process has resulted in fewer but larger companies, able to manufacture and sell throughout the world. This consolidation has been caused mainly by the need to reduce costs through economies of scale in all aspects of the business, from R&D and manufacturing, to purchasing and "back-office" rationalisation involving items such as finance, logistics and advertising. Predictions that the global automotive industry at the vehicle manufacturer level would soon be reduced to four or five major "constellations" or multi-brand groupings appear to have been premature. If the well-documented example of DaimlerChrysler is anything to go by, the strategic prescriptions for globalisation through merger and acquisition are easier in theory than they are in practice. As the tectonic plates of the industry shift under the remorseless pressure of market change, new fault lines and discontinuities appear to be as likely as new consolidated blocks.

DaimlerChrysler constructed a global corporation through cross-shareholdings and alliances, notably with Hyundai of South Korea and Mitsubishi of Japan. Yet within the space of a couple of years these were dismantled, leaving their global strategy in tatters. More recently, much of this global realignment has taken the less invasive or intrusive form of joint ventures, most notably in terms of engine R&D and production. These joint ventures are pragmatic, expedient and ultimately add greatly to the complexity of the inter-corporate landscape. The main problem in terms of legacy management is that the real consequences all too often are found at the local level, in individual plants, facilities, and dealer networks. This is particularly true for manufacturing facilities. The following features of incessant global restructuring are typical:

- Large sums of money have to be spent reversing or rescuing previous decisions.

- Some decisions are simply too difficult or expensive to change (engine supply deals are typical) in the short term and so a pragmatic "live with it" attitude is adopted.
- Some investments are effectively wasted: because the duplication of decisions tends to result in overcapacity.
- The actual facilities get scant chance to enjoy a period of long-run stability under which all the key activities such as management, investment, training, etc., can be embedded.
- Facilities and plants can become "victims" of change almost regardless of actual performance; they are simply in the wrong place at the wrong time.

Multiple brand constellations

A key element behind the rationale for consolidation has been the creation of "multi-brand constellations" with apparently different models and variants derived from a small number of core vehicle structures or platforms. Hence the retention of brands has been based (somewhat paradoxically) on the standardisation achieved with platform strategies (see below).

The primary function of multi-branding in the automotive industry is to avoid or reduce the trend towards product commodification by distinguishing the cars of one manufacturer from those of another. With a large vehicle manufacturers each holding a portfolio of brands, the basic intention is to realise economies of scale through standardisation platform strategies while different segments of the market can be reached through the multiple brands available. This has been the case ever since the 1920s when the newly-formed GM "family" of brands was assembled in order to provide a car for every purse and every purpose. There are perhaps four key elements of brand management in the automotive industry:

- Exclusivity and volume;
- Substantive product differentiation;
- Total brand experience;
- Control over brand values.

Platforms and product diversification

The concept of the "platform" was one that was both universally understood and yet without definite meaning. Fundamentally, the platform concept was based on the vehicle body structure that in turn defined the dimensions and positioning of most of the major components. In practice, the extent to which two different models actually shared components seemed to range widely: from 99.9% (only the badge being changed) to the approximately 25% that the Audi TT shared with the VW Golf IV.

What platform strategies showed is that you can't fool all of the people all of the time: or that, in the end, the market catches up. The same truth was evident with the "parts bin" strategies of the 1970s and 1980s: people who bought Range Rovers did not like the door handles to be shared with the widely vilified Morris Marina. For the 1990s, platforms were an effective, but time-limited, means of reconciling the cost-saving benefits of standardisation against the market demands for difference and diversity.

"Architecture" concepts are a more subtle and analytical attempt to achieve the same compromise. The essence of the architecture approach is to treat the vehicle as a three-dimensional jigsaw of nodes joined by lines of varying length. Different combinations of

nodes and lines yield different shapes. In turn, this means that the automotive industry has a new way to achieve those elusive intermediary volumes (between 20 000 and 100 000 units per annum) in an economical manner. Perhaps the clearest real world manifestation of this thinking is shown in the shift in design from the first Audi A8 to the current generation, and in the design of the controversially styled Fiat Multipla. The models are quite different in their execution, using different materials and forming technologies, but both display architecture concepts.

The idea – as typified by Lotus' VVA concept – is that in all cars the architecture can be resolved to four areas of the structure just inside the wheel-arches. Design for the vehicle starts at these corners, and it is here that all the complexity is concentrated. If accommodated at this stage, it is possible to define a large range of vehicle body configurations and engine layouts from the key corner modules: and because the complexity is concentrated at the corners, so is the cost. The corner modules are common to all vehicles derived from the architecture, and so the per unit costs of each module is as low as possible. The incremental cost of the rest of the architecture, differentiated for each model variant, is relatively low because these elements have been greatly simplified. This approach will come to dominate car body design over the next ten years, as it combines relative flexibility with lower cost.

Purchasing

With an average of 70-75% of the value of a new car being contributed by suppliers, the relationship between the vehicle manufacturers and their supply chain is critical for competitive survival. Collectively, vehicle manufacturers spend over USD 1 trillion per annum on materials and components. In recent years, suppliers have been caught between the demand for cost reduction from the vehicle manufacturers and upward pressure on material prices, particularly steel.

Vehicle manufacturers appear undecided on what sort of relationship they want with their suppliers. On the one hand, there is a demand for proximate suppliers that are able to provide just-in-time assembled modules sequenced into the vehicle build process. On the other hand, most leading vehicle manufacturers have declared the intention to switch more of their purchasing budgets to locations such as eastern Europe, India and China. As ever, the attractions of low cost have to be balanced against increased risk of supply disruption from uneven quality, or logistics difficulties, and indeed an insufficient degree of technical competence.

Vehicle manufacturers now rely increasingly on a small select group of suppliers for the majority of components and materials, as well as expecting those suppliers to undertake R&D and manage their own supply base. This will become the established pattern over the next ten years. New technologies, particularly those associated with ICT and electronics, have opened up the automotive market for new suppliers, such as Microsoft.

Still, the vehicle manufacturers are caught between conflicting desires. On the one hand, they want the benefits of close and enduring partnerships, with suppliers undertaking much of the cost and risk associated with developing new components and technologies. On the other hand, the vehicle manufacturers also want lowest possible costs, and this may mean turning to new suppliers in new locations. Many basic "process" activities such as pressing, injection moulding, and casting, as well as labour-intensive

activities such as assembling wiring harnesses, are no longer competitive in high labour cost locations such as western Europe. A real shift eastwards is therefore likely over the next decade or so, both in Europe and globally.

Technology

An emerging, and increasingly important, aspect of the new car market is that of the introduction of new technologies. The vehicle manufacturers of the world face difficult times. Quite apart from the basic issue of trying to make sufficient profit to stay in business, they are facing ever-stricter environmental requirements that cannot be met with current vehicle technologies. At the same time, nobody knows which technologies will emerge victorious in the long term. There are uncertainties over whether the technologies will work in a satisfactory manner, over whether they will meet the demands of government regulators, and whether consumers will accept them.

It is unlikely that, within the next thirty years, any one technology will emerge as dominant in the way that the internal combustion engine and all-steel body have dominated the last 80 years. Rather, there will be a gradual displacement of traditional petrol and diesel engines, traditional manual and automatic gearboxes, and traditional all-steel bodies by a range of alternatives. The immediate conclusions are:

- There will be an ever greater range of real technical choices for consumers.
- These choices will be packaged into a greater variety of vehicle designs and configurations.
- As a result, the market in its widest sense will become much more complicated for all participants.

At the sub-system level, innovation and product development efforts have been impressive, with improvements in emissions technology, safety systems, lights, brakes and traction control, tyres, heating and ventilation systems, noise insulation, materials, and many mechanical components. More recent innovations include advanced telematics systems, enhanced in-car entertainment, and better vehicle security. Much of this is attributable to R&D efforts by leading suppliers. On the other hand, vehicle complexity has grown and, with this, so too has the tendency for things to go wrong or to be considered over-specified to the task. In other words, there is a clear danger of car technology descending into the baroque. Yet most car manufacturers and suppliers would agree we are just at the beginning of this technology explosion.

Key drivers and trends

The world automotive industry is about to embark on a period of significant, possibly dramatic change. There are a number of drivers for this change. Some of these arise out of the external operating environment of the industry, such as globalisation and government regulation. Others arise out of structural problems within the industry, notably its low levels of profitability. The major drivers for change in the industry are thus structural/economic, regulatory, and technological. Combined, they are creating a new era of uncertainty over the future structure of the industry and the prevailing business models throughout the value chain – from materials suppliers via component suppliers through assemblers, and including retail/distribution and end-of-life processing. Main drivers include the – now apparently structural – poor and declining levels of profitability for vehicle manufacturers and suppliers, especially relative to capital invested, but also in

terms of simple operating margins. This is a long-term issue and no obvious short-term solution is in sight. There is limited scope for further rationalisation. Mass car-making in its current form is chronically unprofitable, which gives some scope for innovative new business models to be introduced. The scope for new entrants is limited by the high entry – and exit – costs of the existing business model.

Considerable cost is added by environmental regulation in mature markets – closely followed by newly motorising markets. This covers especially toxic emissions, but also increasingly fuel economy and CO_2 emissions. New regulatory developments take more of a "life cycle" approach with such initiatives as the End of Life Vehicles Directive in the EU. Pressure is also coming from society to enhance corporate social responsibility (CSR) and accountability, including safety, also for pedestrians. New trends, already established in some markets (*e.g.*, Singapore) involve restrictions on car ownership and use. Much of the leadership has historically come from the California Air Resources Board's (CARB) intervention, but it is increasingly losing the initiative to the EU. CARB is still proactive in its ultimate aim for zero emissions from transport, as illustrated by its efforts to develop the hydrogen economy, notably via the California Fuel Cells Partnership.

Cost

Another pressure comes in the area of cost reduction and market deregulation. Competition has increased with the globalisation of the industry. A sector once dominated by US and European interests is now challenged by manufacturers from Japan, with Korea China, India and others not far behind. In their initial development phase each of these countries has been able to compete on price, at least temporarily. Japan has also been able to compete in manufacturing efficiency, thus transforming practices throughout the industry. In this globalisation process markets have been opened up presenting significant challenges for established local players.

Over the past 40 years, the European Commission's policy emphasis has gradually shifted from industry protection to consumer protection, as exemplified by the Block Exemption for car retailing. This has highlighted price as an issue within the EU and considerable price reduction pressure has been evident throughout the EU in recent years. In North America too, discounting has become endemic, a trend only recently addressed by US car manufacturers. Other pressures come from the World Trade Organisation (WTO) regime, which, though welcomed by the car industry, also increases competition by reducing protectionism. Other cost pressures involve capacity against market growth and the capital cost of new production plants.

Costs also increase as a result of multiple emergent technologies, each of which needs management and engineering input. These include hybrids, fuel cells, latest generation petrol and diesel, aluminium and carbon fibre structures, new powertrain and transmission, electronics in vehicles, intelligent vehicles and highways (telematics), pedestrian protection. As making money on basic cars is no longer possible for many players, attempts are made to sell features, leading to "feature" proliferation, with resulting complexity issues and warranty and reliability problems (*e.g.*, DaimlerChrysler announced in 2004 it was reducing the number of electronic functions in its cars to improve reliability). Nevertheless, the electronics and ICT content of cars will continue to increase, leading ultimately to cars which are essentially electrically/electronically powered and controlled, even if the primary power input still comes from an internal

combustion engine. However this will make the transition to technologies such as fuel cells easier if or when it comes.

Intensified competition has put pressure on manufacturers to improve their manufacturing and supply chain processes in order to reduce costs. This has led to the widespread adoption of lean production systems – based on the Toyota Production System – and of attempts to recapture economies of scale by globalisation. Lean production allows maximum efficiency at any given scale. This means that firms should aim to minimise inputs and maximise outputs – reduce waste. On the other hand, there is the move to increased scale effects as these will still give cost reductions. These are achieved by:

- Buying in more materials, components and services, but reducing in-house production.
- Industrial rationalisation through mergers, liquidations and joint ventures.
- Global integration; produce for a world market, both in terms of cars and components.
- Achieve production synergies through commonality and back office reorganisation.
- Cost pressures are likely to continue, and reinforce the drift of production capacity away from the established regions and into eastern Europe, Latin America and Asia.

Changing supply base

Because of generally lower capital investments compared with the vehicle manufacturers, suppliers are often moving more and faster than vehicle manufacturers themselves. This includes the potential for sourcing from low labour cost locations to assembly facilities in high labour cost locations; although this is still less common in automotive than in some other sectors, it will change over the next ten years. One major struggle involves the reallocation of responsibilities in product development, design and manufacturing. This process of vertical disintegration and redefinition of core competence amounts to a battle between vehicle manufacturers and first tier or "tier 0.5" suppliers – themselves capable of developing and building whole vehicles. Though instigated by some manufacturers as part of a rationalisation and overhead reduction process, others have resisted from the start, while others are now having second thoughts. In the wake of consolidation among vehicle producers has come a wave of consolidation among suppliers. Suppliers are becoming more powerful as a result of these developments and could potentially turn the tables on their customers; a situation which to some extent already exists in the truck industry, where vehicle producers are generally smaller. Ten years from now, some of these super-suppliers will be less disadvantaged *vis-à-vis* the car assemblers.

The cost pressure on suppliers has begun to take its toll, with two major US suppliers filing for Chapter 11 bankruptcy. To some extent this represents the failure of what we may call the American Model where the focus is on low cost, tactical decisions and short-term financial objectives maximising what is perceived as shareholder value. Part of this model also involves small government, which puts a considerable social burden on companies – hence Delphi, Ford and GM's responsibility for the healthcare and pensions of legions of both current and former employees. In Japan, although suppliers have to some extent suffered the gradual collapse of the *keiretsu* structures and many smaller suppliers have been lost, relatively close relationships with manufacturers have remained, enabling both suppliers and manufacturers to plan for the longer term and thus benefit financially. With the widespread collapse of major suppliers in North America and their restructuring into

their EU and Asian divisions, the super-suppliers are therefore likely to emerge in EU or Asia.

In Europe, many suppliers have deliberately embarked on a lifesaving strategy that involves developing intellectual property that can be sold at a fair margin, at least for sufficient time to benefit both supplier and customer. On the other hand, they have started to become more selective about who they do business with – "preferred" customers. Many key European suppliers have been able to benefit from the higher margins engendered by the cost-recovery approach used by Europe's specialist volume producers. Rather than build cars down to a price – cost reduction – as true mass volume producers have to do, these firms, notably BMW and the Mercedes-Benz brand of DaimlerChrysler, can leverage the value of their brand into a premium pricing approach.

Suppliers have benefited from new technologies used by the vehicle manufacturers in market competition, such as satellite navigation and – perhaps surprisingly – airbags, which are still not compulsory but now expected by customers and essential in meeting the semi-official crash standards that have been developed by EuroNCAP in Europe. They have also benefited from new regulations requiring such technologies as on-board diagnostics (OBD) and pedestrian protection systems. The speed with which such new technologies have to be introduced stretches the product design and development capability of many car manufacturers, thus providing opportunities for suppliers with product development capability – such as Bosch or Autoliv – as well as specialist design engineering consultancies such as Ricardo of the UK and AVL of Austria. With the EU currently leading such developments, these suppliers then have products they can sell world wide as other jurisdictions catch up with EU regulation. The key issue for the future is whether high-cost locations and leading companies can retain their status in the face of competitive threats from emerging locations. In practice many of these EU and US businesses are relocating many of their activities – including R&D – to such emerging locations.

Environmental pressures

The recognition that we need to do something about the environmental impact of the car came initially with the realisation that deteriorating urban air quality – initially primarily in southern California – was car-related. This prompted a wave of toxic emissions regulation from the 1960s onwards aimed at controlling the harmful side-effects of automobility, which has extended into more and more aspects of the car, its production, and its use. Regulation now extends to safety, noise, and fuel efficiency and is likely to take an increasingly holistic or life-cycle perspective. The regulatory approach, with successive generations of emissions standards, has created vehicles that are much improved in many respects. A modern car, driven under the right conditions, can be up to 95-99% "cleaner" in terms of toxic emissions than its equivalent of 30 years ago. By 2008, EU trucks will have improved such that it will need ten trucks to produce the same emissions as were produced by a truck built in the late 1980s. While individual vehicles have become cleaner, quieter, more durable, more able to be recycled, and in some respects more efficient, various 'rebound' factors have combined to undermine these achievements.

First, there is the fact that vehicle numbers have increased considerably, the distances driven have increased and growing congestion has resulted in longer periods where stationary cars continue to consume fuel and produce emissions. In addition, cars

themselves have become heavier, more complex with many more comfort and safety features, while there has been a move – led by the US – from cars into generally heavier Sports Utility Vehicles (SUVs), pick-up trucks and minivans or people carriers for personal transport. Just as importantly, the newly motorising economies of China, India, Indonesia, Russia or Brazil are potentially markets of such magnitude that collectively they can easily outgrow the established 'triad' markets of EU, North America and Japan within the next 20 or 30 years, thus doubling the global burden of motorisation. The key issue here is whether harmonisation of global environmental standards can be achieved, and at what cost.

Climate change and oil

The looming issue of global warming and the link to petroleum consumption is particularly challenging, and one that may be expected to take centre stage in the future as toxic emissions *per se* are dealt with. The science behind climate change while still debated in some areas is now widely accepted by policy makers around the world. What is still unclear, though, is the extent to which we humans contribute to climate change. On the other hand, we are rarely 100% certain about any risk, yet most of us take out insurance against various risks and pay the premiums in the hope we never need to claim. This is the basis of the precautionary principle that guides much of our current political response to climate change. Some credit should go to the European car manufacturers – and to some extent also their Japanese competitors – for what they have already achieved. The number of cars now available that do meet the 140 g/km agreed with the Commission has increased significantly since the agreement was implemented; and people are buying them. In fact, there are several cars available in EU and Asian markets that already meet the 120 g/km proposed for 2012 by the Commission.

What have been lagging behind, are any true incentives for buyers of cars to choose these lower CO_2-emitting vehicles. Some countries have made moves to adjust their regulation – the UK's CO_2-based company car tax regime is an example – and many countries have traditionally favoured smaller, less powerful or more fuel-efficient cars in their taxation regimes. China has recently introduced measures favouring smaller cars and diesel cars, but others are well behind. Consumers themselves have therefore not been party to the agreement between ACEA (European Automobile Manufacturers Association) and the Commission. This would need to be remedied. One possible solution may come from rising oil prices. The effects of this are already visible in the United States, where a lower proportion of the price of fuel is represented by taxes and where oil-price increases translate into pump-price increases much faster than in Europe. This has prompted the introduction of tighter light truck fuel economy standards under the CAFE regime (Corporate Average Fuel Economy).

The price of oil has already risen to unprecedented levels. As the point of "peak oil" is reached, perhaps as early as 2010, price pressure will grow. Rapidly increasing demand from newly industrialising – and motorising – nations will speed up the decline in the availability of cheap oil and of many raw materials needed for car making, such as precious metals for catalysts. In addition, dependence on Middle East oil has now become a political issue, especially in the United States. Concern for dwindling supplies and political dependence may galvanise governments into action faster than issues related to global warming. There could be profound consequences for the industry, and indeed the global economy. Overall sales volume growth may not be achieved, putting further

pressure on the industry. Additionally, major shifts in vehicle design and the segment split of sales are likely, greatly increasing risks and uncertainty for the vehicle manufacturers.

Environmental regulation

Environmental regulation has traditionally been regarded in the automotive sector as something that holds the industry back, a cost without any business benefits. The industry has therefore rarely been proactive in environmental technology. Car manufacturers, particularly in the United States, but also – albeit to a lesser extent – in Europe, have spent considerable efforts and resources over the past few decades attempting to stop the introduction of new environmental rules and regulations. However, this view is beginning to be challenged by some of the biggest players in the industry. Toyota has made it quite clear it intends to use its technological advantage in hybrid and fuel cell technology as a competitive tool in the market. In fact, it intends to use its considerable financial and technological leverage to move the whole industry in that same direction. Having established the direction for the whole sector, it can profile itself as the leader and its competitors as followers, benefiting immediately from a first-comer advantage. Toyota is not alone. PSA Peugeot-Citroën caught its German competitors off-guard in their own German home market by offering particulate filters as standard on its new Hdi diesel engines.

It has become quite clear that environmental technologies are beginning to be used as a competitive tool. Toyota has laid down the gauntlet, but PSA has also taken the initiative in the German market. If others wake up to the possibilities offered by the CO_2 reduction agenda and the California-inspired Japanese drive into hybrid and fuel cell technologies, our environment can only benefit. At the same time this new approach could change the industrial landscape and the way the car industry interfaces with government and regulators. This is an example of an external driver being internalised by the industry and being turned into a competitive tool. In the long term such a scenario will of course make the industry more sustainable, both from an economic and an environmental viewpoint. By implication, in the future individual vehicle manufacturers, their technology partner suppliers, and/or particular locations will be looking more aggressively to establish market technology leadership. In this sense, the Toyota case could for example accelerate the deployment of fuel cell vehicles.

Västra Götaland Region, Sweden

Introduction and basic data about the region

The industrial geography of Sweden, as in other member-states of the OECD, can be understood in terms of regions and clusters which concentrate different types of industrial expertise and know-how. Sweden has, since the 1990s, experienced a process of decentralisation and growing autonomy of its regions, although it remains a unitary state. Sweden's regions and the companies they host have done relatively well, by international standards, in terms of economic performance and competitiveness.

Swedish regions nonetheless confront significant challenges of adjustment to changes associated with globalisation, the emerging knowledge-based economy, and broader industrial transformations, similar to those in other European Union (EU) states. These challenges are nowhere more clearly identifiable than in the manufacturing base of the

country's economy, especially in the automotive sector which accounts for a major part of the country's economic activity in terms of employment and exports.

Specific regions, specialising in different phases of the automotive production process, comprise the Swedish automotive sector. The region of Västra Götaland in the south-west part of the country is the centre of the sector: a large county with 49 municipalities and a metropolitan area that is home to more than half of the region's total population of 1.5 million. The region is referred to as the "second region" – the first being that surrounding Stockholm – with a geographical area of 24 000 km^2. However, it constitutes a leading manufacturing and trading hub. Gothenburg is the centre of a travel-to-work area with approximately 940 000 inhabitants.

The Regional Council and Local Authorities make up the administrative structure of the region. *Region Västra Götaland* (*www.vgregion.se*), the Regional Council, is the central political decision-making body in the region. With regional development tasks including support for infrastructure development such as transportation and communications, business development, knowledge and skills development, international co-operation, analysis and assessment of economic trends, and the management of programmes for development and social cohesion funded by the EU, it is also responsible for creating conditions favourable to economic development and the promotion of trade. The *Region Västra Götaland* is also responsible, beyond these functions, for healthcare, which is its primary responsibility, the promotion of culture, tourism, and environmental protection issues, thus exercising a wider influence on the region's welfare.

The municipalities of the Västra Götaland region, the so-called Local Authorities, constitute the support infrastructure for all public services provided at municipal level. Collaborating with *Region Västra Götaland* on matters of regional economic development, they are organised into four associations. The Local Authorities have, like the *Region*, the power to raise taxes from their constituencies in order to finance their activities.

Despite the fact that it is a unitary state, Sweden has a public administrative structure where the interpretation and implementation of national policy take place at national and regional levels. Regions and municipalities have relative autonomy on how to interpret and apply national laws, raise income tax, and implement various policy objectives set at national level through the use of subsidies, while legislation and fiscal policy are the responsibility of the national level.

The general trend in Sweden, as in other EU member-states is toward devolution of policy-making authority to the regions. On 1 January 1999, as part of this trend, Västra Götaland became a self-governing region with directly-elected representatives assuming responsibility for regional development.

The co-ordinating work of the Drafting Committee for Regional Development ensures commitment and co-operation among the region's stakeholders and municipalities around the objectives of regional development. Political representatives from *Region Västra Götaland* and the Local Authorities make up the Committee. A strategic framework for the region is its focus, built around a regional vision and growth programme, infrastructure planning, and EU cohesion policy. Formed at regional and sub-regional levels, partnerships among key stakeholders such as companies, unions, universities and other applied science organisations of civil society, carry out these lines of activity.

The Västra Götaland region is supported by an extensive education and research infrastructure, given its centrality as a manufacturing and trade centre. Three universities

with specialisations in the fields of technology, natural sciences and architecture, but also disciplines such as economics, law, medicine and information technologies form part of this infrastructure. In addition, there are three University colleges which, apart from classical studies, also offer programmes such as computer sciences and engineering.

Gothenburg is a vital part of Swedish industry, business, shipping, education and culture. The city was founded in 1621, and grew to be an important centre of trade and industry. Among the first important industries to be developed in the city were shipping and trading, shipbuilding and engineering; full industrialisation arrived during the 19th century. The industrial history of the region was dominated by the same industries for much of the 20th century, even though during the last quarter of the century several of them, such as shipbuilding, suffered delocalisation or closure.

The industrial structure today is diversified across sectors such as automotive, petrochemicals, information technologies, aerospace and textiles. The region is also an attraction pole, given its accumulated expertise, for a large number of international companies which have located operations in and around Gothenburg. The presence of the automotive industry, led by Volvo and Saab, is one important element of attraction, as well as several major chemical companies such as Akzo Nobel and Eka Chemicals. International companies of high specialisation are attracted by the advanced research and production activities carried out by these companies, with a positive cumulative effect for the entire regional economy. The Gothenburg region is one of the fastest-growing regions of northern Europe as a result.

Per capita gross regional product (GRP) for Västra Götaland was 5% above the EU15 average in 2003. Services such as healthcare, education and public services, provide the majority of the jobs, in terms of employment composition across different sectors, with the remainder being in manufacturing. Unemployment levels, however, have been comparable to those at the national level despite a generally high level of education. What is more, levels of unemployment tend to vary across different areas of the region, which indicates the absence of a common labour market, with remote areas not being fully integrated into the economic dynamics of the Västra Götaland region. Transportation infrastructure investment, as a result, is a public priority in order to reduce the vulnerability of remote areas of the region.

The economy of Västra Götaland displays a well-balanced distribution between small and medium-size enterprises (SMEs) and large firms, in terms of its firm structure. Firms with 1-9 employees, for instance, represent 17% of the total, while firms with 10-49 employees represent 29%, firms with 50-250 employees represent 29%, and firms with more than 250 employees 25%. Within a well-diversified economic base spanning textiles, petrochemicals, automotive and fishing and aquaculture among others, these companies exhibit high degrees of specialisation.

The automotive sector in Västra Götaland

Historically, vehicle manufacturing has been the core business of the Swedish automotive sector. The motor of the industry is constituted by the major vehicle manufactures (AB Volvo, Volvo Car Corporation and Saab Automobile) and their suppliers (such as SKF, Autoliv, Haldex and Opcon). These companies conduct automotive R&D through universities and research institutes, and play a significant role in the development of Sweden's automotive sector. The industry is structured, beyond these

major firms, around approximately 200 SMEs that act as suppliers of components and services.

The automotive industry, taken as a whole, employs over 50 000 people, which represents a major part of employment in the manufacturing base of the region. Beyond its significance for employment, however, the automotive industry acts as a driver of technological R&D as it accounts for a significant share of Swedish exports; it also functions as an engine of growth for other industrial sectors (Ministry of Industry, Employment and Communications, 2005).

The industry confirmed its position as an engine of growth for Västra Götaland and Sweden in general in 2004, after reaching record production levels of passenger vehicles and heavy duty trucks, The combined strengths of the industry are reflected in its performance, with production of Volvo Cars and Saab Automobile increasing by 7%, reaching a total of 587 000 units, half of them being produced in Sweden. An increase of 24% from 2003, totalling 150 000 Volvo and Scania truck sales world wide, was also experienced in heavy duty truck production. Approximately 85% of the production of passenger cars and 95% of trucks and buses were sold outside Sweden.

Sweden's growing dependence on exports is also highlighted by this performance. In 1968, for instance, exports accounted for about 20% of the country's GDP; in 1998, consolidating the industry's position as the country's largest exporter, the figure had risen to 42%, with the automotive industry being responsible for a major portion of this increase. In addition, the automotive industry accounts for approximately 25% of Sweden's total investment in industrial R&D and 20% of its investment in machinery and equipment. In 2003, according to Statistics Sweden, the manufacture of transport equipment accounted for 27% of total industrial R&D investment and for 30% of all employees in the industrial R&D sector as a whole (Ministry of Industry, Employment and Communications, 2005).

Despite the historic strengths of the Swedish automotive sector, Västra Götaland faces challenges associated with transformations in global production systems and the emerging economies. The automotive industry today is a global competition arena where business rules and conditions often are defined by larger groups. The very core of the industry, moreover, Volvo Cars and Saab, is owned by foreign groups Ford and GM respectively. It must adapt, therefore, to the strategies pursued by the owner groups which are defined on a global, rather than a regional, basis.

The challenge for the automotive manufacturers and suppliers is one of adjusting to realities while seizing market opportunities that might arise. It is a matter for the national and regional governments of creating conditions that enable the industry to defend and enhance its position and create growth. The region is uncertain about its future in the long run, as this depends largely on decisions taken elsewhere and according to criteria that might not correspond to the priorities of the region.

Västra Götaland is confronted by another important transformation: mounting competitive pressure from emerging economies and the changing global geographical distribution of the automotive production process. Europe headed global vehicle manufacturing in terms of number of vehicles produced until the end of the 1990s, followed by North America and Asia. Asia is the dominant producer today, with 36% of world production, with Europe and North America following, with 33% and 30%, respectively.

Low-cost countries with substantially lower wage costs are Västra Götaland's main rivals. In some parts of Asia and eastern Europe, labour costs are often less than 10% of average labour costs in OECD countries. This reality has profoundly affected the industry, and its consequences for manufacturers and component suppliers are unclear (Ministry of Industry, Employment and Communications, 2005).

The disaggregating of the automotive value chain and the location of different phases of the production process in different regions according to optimum production and profitability criteria are also a reflection of these differentials. Swedish major manufacturers, nonetheless, undertake the entire process, from product development to the manufacture of finished cars. A seamless working infrastructure, including an efficient supplier network, is a requisite for this process. Cost effectiveness, which is increasingly defined on a global scale, is another major factor, which makes manufacturers and suppliers vulnerable to cost pressures.

Manufacturers, at the same time, are following the tendency in the value chain to place increasing value on the immaterial aspects of automobile production, namely design and other advanced engineering functions as opposed to vehicle manufacturing. Although automotive manufacturing continues to be among the most capital-intensive industrial activities, manufacturers tend increasingly to focus on other areas to boost profitability, reduce risk and access wider market targets, including brand values and branding, marketing, maintenance, financing and insurance. The relationship between manufacturers and suppliers is changing in the process. Increasingly, suppliers are expanding their operations in manufacturing and product development; and now constitute the bulk of the automotive industry in terms of value added. They are under pressure, as a result, from more cost-effective locations and manufacturers to find ways to increase their cost-effectiveness while increasing investment in R&D. The relationships between manufacturers and suppliers have changed as a result, with the burden of adjustment being shouldered increasingly by the latter. According to interviews conducted for this study, suppliers have, in fact, become the shock absorbers for the automotive industry's fluctuations.

Increasingly, competitiveness in the automotive industry is based on high levels of expertise, R&D, and cost-effective production. A paradigm change that requires the integration of new technologies and the development of new technological solutions has shaken the industry. Fuel, safety, accessibility and the environment are just some of the key areas requiring new technological solutions. Interviews conducted for this report point out that such integration will take time, possibly 10 to 20 years; moreover, success will depend largely on R&D.

The automotive industry is an important sector in Västra Götaland and the importance of the industry in recent decades as an employment-provider has increased even further as manufacturers and suppliers have not relocated their operations to other locations or reduced their workforce in Sweden. General employment in the sector, however, has fallen by 20-30 000 since the early 1990s. The geographical concentration of the industry across a broad corridor between Västra Götaland and Södertjälje/Stockholm has, moreover, increased the importance of the industry from the standpoint of regional policy; the various companies across the region being the dominant employers in the localities in which they operate (Ministry of Industry, Employment and Communications, 2005). However, it should also be underlined that

the regional economy in Västra Götaland has become increasingly diversified during the latest years.

Regional governance and strategies

Different levels of government have introduced initiatives, against this background, to boost the innovative and adaptive capacities of the country and the regions. The national government published a report in June 2004 outlining its innovation strategy, *Innovative Sweden: A Strategy for Growth through Renewal* (see *www.sweden.gov.se/sb/d/2026/a/32551*). A framework for enhancing Sweden's position as a knowledge economy is outlined in this strategy. Changes in the structural conditions of policy intervention are reflected in this approach: having moved from generic intervention, to industrial sector targeting, to industrial structure ("parametric" policies).

The national framework for innovation policy and initiatives is set by *Innovative Sweden; Vision Västra Götaland – A Good Life* lays out the vision of the region (see *www.vgregion.se/upload/Regionkanslierna/regionutveckling/RUSEN/PP-pres%20eng.ppt*). Jointly formulated by *Region Västra Götaland* and the four regional associations of local authorities, the vision is a product of a collaboration of a number of parties representing trade and industry, universities and colleges, and other organisations. On 5 April 2005, it was adopted by the Regional Council.

As a framework to organise regional actions in order to enhance the region's appeal as a place in which to live and work, *Vision Västra Götaland* specifies long-term objectives. Health, work and education opportunities, safety, community spirit and social inclusion, a good environment protecting renewable systems, addressing the needs of the young, sustained growth and promoting cultural life are the core of the vision. Sustainable development is required, based on mutually reinforcing relationships between and across economic, social and environmental conditions.

The *Vision* has five focus areas in terms of economic policy intervention: support for sustainable trade and industry, support for a leading position in competence and knowledge development, support for the development of infrastructure and high standard communications, support for the cultural life of the region, and support for health. Through an approach which centres on social cohesion, equality, integration and internationalisation, these are thought to be achievable.

The *Regional Growth Program* is another initiative co-ordinated by the regional government. Designed to mobilise system-oriented change activities focused on the region's trade and industrial requirements, the main objective of this plan is to concentrate national and regional funds for sustainable regional development through regional and local partnerships. Regional government agencies responsible for innovation, education, labour market regulation, transport and cultural policy are its main stakeholders. For the implementation of the *Regional Growth Program,* the key institutional instrumentality responsible is *Region Västra Götaland*.

The strategy to address the challenges of the automotive sector has been formulated within the general economic strategy of the region, based on the view that Västra Götaland must compete not on low wages but rather on the strength of its expertise and potential for innovation. It aims to enable the industry to maintain its position in the global automotive value chain through the development and introduction of advanced technology solutions in international markets. The vision of the role of government policy in the strategy is to

create conditions that will enable the industry to maintain world-class institutions of R&D within a stable macroeconomic environment, and a dynamic business climate supported by efficient innovation systems.

A study commissioned to the Center for Market Analysis (CMA) in 2003 identified several positive elements in the current state of the industry, such as the structure of the industry which encourages collaboration, the ability to develop quality products to meet emerging demands, the cost-effectiveness of engineering across the sector, and the existence of high skills areas that will be critical to future competitiveness such as environment, telematics, and new materials. The study zeroed in on certain competitive disadvantages, on the other hand, including difficulties to adapt to rapid changes in the international business environment, low productivity, high dependence of the sector on Swedish manufacturers, and hence their foreign owners, limited and mostly regional networks, a relative disconnect between academic institutions and industry, and infrastructure.

These findings prompted the formation of *Automotive Sweden* in 2004, confirming the commitment of public authorities at different levels of government to the sector in the region (see *www.automotivesweden.se*). Established by the public sector, *Automotive Sweden* is a network to help promote the development of the automotive sector. The network's strategic objective, in co-operation with industry and academia, is to help foster a favourable business environment for the industry, support R&D and the long-term development of skills in emerging critical areas. The focuses of its business development programme include: 1) business intelligence (to increase knowledge and awareness); 2) co-operation (to support existing and new players); and 3) marketing (to attract new companies and skills).

The historic sources of the Swedish automotive industry's strengths, which cross different sectors and domains of expertise, are the framework for *Automotive Sweden*; these include environment, safety, telematics, design and engineering, and winter testing. These competencies are the focus of the industry in its quest for international competitiveness.

Other priorities in the Swedish government's initiatives to support the sector are automotive safety and the elimination of vehicle accident-related casualties. "Vision Zero", for instance, is a government-sponsored programme, supporting the development of advanced safety features and systems. The Intelligent Vehicles Safety Systems (IVSS) programme designed to help introduce new safety solutions in vehicle and roadside systems are another government-sponsored initiative. This programme is regarded, additionally, as a driver for the development of skills that will be critical for research and education as well as a platform for the development and application of advanced information technologies in the automotive production process.

The convergence between automotive and information technologies is another object of *Automotive Sweden*'s concerns; this convergence is regarded as a key competence in the industry's positioning as a leader in telematics, given the country's industrial experience in both sectors (Volvo Cars, Volvo Trucks, Saab and Scania in automotive; Ericsson in information technology). "Telematics Valley" is result of this convergence, an automotive telematics cluster around Västra Götaland. As a centre of innovation hosting developers and producers of hardware, software, and services, as well as telecommunications vendors and operators, it is also home to leading international automotive manufacturers and suppliers.

Another area of strategic action of *Automotive Sweden* is the combination of Sweden's experience in design and engineering with the dynamics of automotive production; the objective here is to combine skills that cross these domains and lead to the development of world-class products that confirm Swedish production values such as excellence in industrial design, product durability, road-holding ability and style.

A number of areas have been identified where co-operation in the automotive sector can be further improved and where initiatives can be implemented to reinforce the position of strength enjoyed by the automotive industry. The initiatives are grouped into the following areas: measures to promote closer interplay between the government and the business sector; measures to improve know-how and expertise and raise the level of technology in strategic areas; measures to ensure skills provision and access to labour; measures to facilitate pilot projects and the demonstration of new technologies and systems; and measures to develop the potential of Swedish suppliers to the automotive industry (Ministry of Industry, Employment and Communications, 2005).

The *Regional Growth Program's* main objective is to promote an innovative economy across the Västra Götaland region. For achieving this goal, clusters are seen as key vehicles, along with the promotion of entrepreneurship and initiatives targeted to support SMEs. Nine clusters have been prioritised by the *Regional Growth Program* as well as cross-cluster initiatives which seek to create synergies across them. These are life sciences and healthcare, automotive, ICT, food, petrochemicals, textiles, wood and creative industries. Also in the programme are measures to further promote design, logistics and financial services.

Intended to position the region as a pole of attraction of investment and competence, this multifaceted approach views cluster support not as an objective in itself but rather an integral component of the regional strategy for economic development. It is to be developed through continuous dialogue with key regional stakeholders, the role of public agencies differing according to their functional responsibilities. *Business Region Gothenburg* thus targets its activities to the support of start-ups and organisation of cluster initiatives, providing, for example, project managers and networking opportunities; *Västra Götaland Region's* role, on the other hand, is to co-finance cluster development and help stimulate cross-sector initiatives.

The development of cluster initiatives or networks, based on co-operation between industry, academia and the public sector on local, regional and national levels is the key instrument used to achieve the *Regional Growth Program's* objectives. Initiatives on a cluster level are defined and objectives prioritised through such partnerships. Co-operation across research, business and competence development, and internationalisation are some of the concrete actions involved. One of the key instruments to support innovative clusters is horizontal action focused on the priorities of industry and the targets of regional economic development. Another prioritised instrument are centres of excellence, or arenas for co-operation. Designed to stimulate synergies across the competences of different stakeholders by facilitating co-operation between companies in different sectors and academia in ways that foster innovation but also attract competencies and investment in the region, these centres can be located in a science park, a university or research institute which provide the facilities of incubators (including test and demonstration facilities, managerial advice, and networking) for the promotion of start-up companies.

The innovation strategy for the automotive sector that was presented by the Swedish government in 2005 reflects this approach. Based on a model of co-operation across industry, regional government, and academic and research institutions, key actions were identified. A number of actions, such as the promotion of "Test Site Sweden" and the establishment of a "think tank" for policy measures in the automotive sector, are to be the responsibility of the different stakeholders across these communities. The more detailed phases of implementation involve more specialised institutions, even though *Region Västra Götaland* and *Business Region Gothenburg* (see *www.businessregion.se*) have overall responsibility for the development of these centres, The *Lindholmen Science Park* (see *www.lindholmen.se*) in Gothenburg thus plays a key role in the development of "Test Site Sweden" while the *Chalmers School of Technology* (see *www.chalmers.se*), *Gothenburg University* and *Automotive Sweden* are important stakeholders in the development of the "think tank".

Besides the above initiatives, the Swedish Government in 2004 initiated two special programmes to strengthen the international competitiveness of Swedish car manufactures. The two programmes were directed at developing production technology and telematics and vehicle electronics. The total budget for the programmes is roughly SEK 1 billion or about USD 110 million. The programmes are conducted in co-operation with the Swedish car manufacturers, the Swedish Agency for Innovation Systems (Vinnova), the Swedish Agency for Economic and Regional Growth (Nutek), the region of Västra Götaland and the Scandinavian Automotive Suppliers.

General conclusion

The Västra Götaland region and the automotive cluster around Gothenburg, in comparison to other EU regions, have performed relatively well over the past several years. Like other regions across the EU, however, they face strategic challenges associated with changes in the global automotive industry which could have a dramatic impact on the economy of the region. Several key points presented here are highlighted:

- The experience of the Västra Götaland automotive cluster points out the importance of government support, at both national and regional levels, especially in the provision of an "enabling framework" to assist the industry in defending and promoting its position in international markets. The collaboration between government institutions with industry but also collaboration across different levels of government is one particularly critical component.
- In the context of the strategic orientation to compete on the historic strengths of the industry instead of low cost, this framework is particularly important. In the development of a long-term approach to critical skills development and putting into place infrastructures that will play a key role in the future of the industry, it is a critical factor.
- The Västra Götaland case, however, also highlights the challenges associated with corporate control. With foreign control of the very core of the Swedish automotive industry, it could be harder to influence critical investment decisions and strategic direction, apart from providing the conditions necessary for global competitiveness, which, when considered in the context of wider global strategies, might or might not address the concerns of those who are ultimately in corporate control of the industry.

The following tentative suggestions for policy may be advanced based on the foregoing analysis:

- A "total" approach to the design and production of automobiles continues to mark the Swedish automotive industry. Given the global dynamics which affect the industry, however, as well as the significant cost differentials across different regions, this orientation might no longer be tenable.
- In the Västra Götaland region, the automotive cluster concentrates significant competencies that will play a major role in automotive production competitiveness in the future. In collaboration with the stakeholders in the industry, the government needs to develop a strategic approach that focuses on the segmentation of the global automotive production value chain and concentrate on its high-value components, as opposed to seeking to address the whole production process.
- This approach must be flanked, in parallel, by programmes and measures that assist the regional SMEs either to internationalise their activities (*e.g.*, enter into highly specialised subcontracting arrangements with international automobile manufacturers and/or diversify their activities into other industrial sectors).
- Such an approach would reduce the dependence of the Västra Götaland region on exports of automobiles while it would provide a more diversified economic base for the region's development which would also reduce its dependence on the fluctuations of the automotive industry. Not the least benefit would be reducing the uncertainties linked to the foreign control of the very heart of the automotive industry regional and national governments seek to support.

Turin, Italy

Introduction and basic data about the region

Piedmont is a region of north-west Italy with the city of Turin at its centre. Piedmont has historically been a core of the industrial and economic fabric of the Italian economy, concentrating major industrial activities ranging from automobile production to telecommunications and information and communications technologies (ICT). The region of Piedmont and the city of Turin constitute a major industrial centre, known particularly as home to the headquarters of Fiat. Turin is also the birthplace of major pillars of the Italian economy, like telecommunications (Telecom Italia), television (Rai, National TV channel) and cinema. Most of these industries have over the years migrated to other parts of Italy, but Turin is still a major hub of industrial activities which span several sectors.

Given its industrial history and accumulated competencies, the region concentrates key elements of a vibrant "enabling framework" that are usually encountered in dynamic clusters. Some of these include the following:

- Universities and research centres of high-quality research capabilities in leading technological fields.
- A research community which among other types of expertise includes almost 20% of Italy's researchers in ICT.
- World-class companies in sectors such as automotive, telecommunications, ICT, and aeronautics.
- A diversified base of SMEs which intervene at different sectors and levels of expertise in production processes with large firms within but also outside the regional economy.

- Availability of public and private funding to support both research activities and the creation of new entrepreneurial initiatives (Piedmont invests 2.5% of its GDP in innovation and attracts a quarter of all Italian private investment in R&D).
- A regional government engaged in nurturing favourable environmental and infrastructural conditions for new enterprises.

The automotive sector in Turin

The automotive sector in Turin has historically been structured around Fiat which was established in the city in 1899 and has dominated automotive production in the region ever since. For more than 100 years, Fiat has developed multiple activities at an international level in the motor industry. Besides its automobile core business, with brands like Fiat, Lancia, Alfa Romeo, Ferrari and Maserati, Fiat produces trucks and commercial vehicles, under the brand of Iveco, and agricultural and construction equipment, under the brands of Case and New Holland.

The automotive sector has been central to the region's welfare in terms of employment and forward and backward linkages to other sectors in the regional economy. The automotive cluster has developed largely due to a growing supply chain around Fiat, without an identifiable government strategy. Indeed, according to interviews conducted for this report the automotive sector, given its maturity as an industry in Turin, seems less in need of a formal cluster policy programme. Yet, despite the absence of a formal definition of the automotive sector as a cluster, the sector has had a decisive influence, in the case of Fiat, on regional politics and the relationship of the region to the national government since the 1950s.

However, for reasons related to processes such as European integration and the introduction of the euro, globalisation, and the emergence of new economic powers and reasons specific to the operations of Fiat, the automotive sector in and around Turin has undergone significant changes over the past 10 years. Moreover, these changes have been related to heightened competitive pressures and missed market targets by Fiat which played a major role in its near collapse in 2003.

The combined effect of these changes has been a reconfiguration of the basic economic relationships that structure the automotive sector. Though delocalisation and outsourcing have played an important role in this, it is a reinforced focus of automobile manufacturers on core business and high productivity that has been the key factor in the transformation of the automotive sector. One major aspect of this has been a dramatic reduction of employment. Until the mid-1990s the sector employed 80 000 people; today it employs approximately 25 000.

Another major impact of the change has been the emergence of new relationships between Fiat and its supplier base in the region. Fiat has historically had a broad supply base composed of a large number of SMEs located in and around Turin and throughout the province. The number of these enterprises grew substantially after World War II. This growth was largely the effect of labour "spillover" from Fiat whereby specialised workers set up their own businesses to act as suppliers to it. The relationships among these SMEs and Fiat were based on a variety of models. However, the "one-to-one" model of vertical integration, involving exclusive relationships of specialised SMEs to Fiat, was pre-eminent.

Over the past 10 years the relationships between these firms and Fiat have been disrupted by changes associated with Fiat's mounting crisis, which peaked in 2003. The

crisis has had different implications for the SMEs and has generated different responses. There are three discernible patterns of response: 1) a number of SMEs have closed as a result of their inability to diversify their business activities, either toward other international automotive manufacturers or other industrial sectors; 2) a significant number of SMEs have, by default, reinforced their "one-to-one" relationship with Fiat; 3) another part has diversified their activities internationally becoming specialised component suppliers to European car manufacturers such as Volkswagen, Daimler-Chrysler, BMW, and others.

Against this background, the restructuring of the automotive sector presents a big challenge for policy makers in Turin. According to interviews conducted for this report, Fiat is "top heavy" and too "old economy" with little commitment to the region, which makes it part of the problem the regional economy faces, not part of the solution. However, given the economic centrality of the sector and the widespread automotive culture in the region, it is still regarded as a key sector not so much with respect to employment or strategic economic importance but in terms of introducing and testing new technologies ranging from ecological engines to greater ICT use in the production and use of automobiles, R&D and design, and the development of advanced transportation and logistics infrastructures.

On the other hand, several policy makers and industry leaders stress that the Turin automotive cluster is keenly aware of the changes in the global automotive value chain. These changes involve a shift in the automotive production and consumption cycle where a higher value added is increasingly placed on the components of automobile design and innovations in engineering, and less on the actual manufacturing of automobiles. As a result, given the region's internationally recognised position as a world-class centre of automotive design, the emphasis of the cluster is increasingly on the global positioning of Turin as a "one stop" international centre of excellence in design and innovation in global automotive markets, not exclusively or primarily linked to Fiat.

Indeed, according to interviews, many consider that the crisis of Fiat and the ensuing restructuring of the Turin automotive cluster has forced the key players, especially among SMEs, to focus on core business and has resulted in a more robust, competitive and internationally oriented economic position, both in the traditional relationships between Fiat and its regional supplier base and in terms of dynamic companies specialising in automotive design and engineering. This robustness prepares them for accessing global production and design circuits and provides a solid capability in Turin's global orientation.

Regional governance and strategies

In light of the changes affecting the automotive sector the regional authorities have made great efforts to assist the process of restructuring and adjustment, not only of the sector itself but of the regional economy as a whole. Such efforts have focused on labour market policies with a focus on training, especially in leading technologies such as ICT, but increasingly also on innovation and R&D with an emphasis on technological districts and greater involvement of universities and public institutions in different programmes involving the economic base of the region.

Efforts to develop a comprehensive strategy to address the problems the region faces have been complicated by changes in regional governments and occasional shifting of priorities related to regional political pressures.

The case of Turin highlights the dual nature of institutions, formal and informal. Formal codified strategies with clearly specified roles and responsibilities are more characteristic of countries such as France, Germany and the Scandinavian countries. In contrast, Turin's relatively loosely organised approach reflects the informal nature of institutions predominant in southern European countries.

Italy has no national industrial policy that specifically addresses clusters, though there is a tradition of support programmes and legal frameworks that allow public funding to be directed at groups of firms (specifically those located in designated industrial districts). Clusters come under the framework of National Economic Policy which emphasises decentralisation and regional autonomy in matters of economic development. In Piedmont, the approach to cluster support is "parametric" in that it seeks to create an environment that facilitates economic adjustment through the migration of companies to higher value added, technology- and knowledge-based economic activities.

In the last 10 years, more focus has been put on innovation and R&D and there is a general policy and institutional framework that is recognised as a regional economic strategy even though it would be simplistic to suggest clear-cut structures of leadership and co-operation mechanisms. Instead it would be more realistic to understand such a strategic framework as a product of loosely co-ordinated actions of key agencies responsible for regional economic development, since there is no overall strategy for these development projects.

In terms of its institutional instrumentalities the strategy has been carried out through four loosely interconnected "platforms", as they are known in the region. Their objective is to contribute to the economic transformation of the region and facilitate the passage of regional companies to higher technological- and knowledge-intensive forms of economic activity such as health sciences and healthcare, aeronautics, ICT and logistics. For instance, SMEs with high levels of specialisation in the automotive sector could, with appropriate reconfiguration of their business competencies and skills composition, diversify their activities toward the aeronautics industry. A diversified economic base of the region of Turin is regarded by regional policy makers as an enabling condition that can enhance the dynamism and economic transformation of the region.

The "platforms" are concentrated in the automotive, ICT, aeronautics and transportation sectors.

The *automotive cluster*, largely structured around the *Fiat Research Center* (CRF) (see *www.crf.it*), has a mission to develop and transfer innovative products, processes and methods to the automotive and other industrial operating units of the Fiat Group. CRF is deemed to have the potential to enhance the competitiveness not only of the Fiat Group, but also that of its supplier SMEs.

The *ICT cluster* is centred on the *Torino Wireless Foundation* (see *www.torinowireless.it*), founded in 2002. It brings together the key ICT stakeholders in the Piedmont region in a common framework of strategies, and actions in order to increase the competitiveness of the region through the integration of R&D, entrepreneurship and venture capital.

The *aeronautics cluster* is built around *Alenia Aeronautica* which was established in 2000 as the new corporate entity that replaced Finmeccanica (see *www.alenia-aeronautica.it*). *Alenia* is well-known in the field of aeronautics with a tradition of autonomous development in specialised competences in several fields spanning R&D, integration of systems, production and commercialisation.

The *transportation cluster* is constructed around *T5*, a private-public entity dedicated to the promotion of R&D in advanced transportation and logistics systems in the Piedmont region and the city of Turin.

However, the "platform" approach to economic adjustment and innovation has been criticised as being out of touch with the structural realities of the economy of the region and lacking an overall strategic framework. The diversification into different new sectors is done in an autonomous way with no governance framework.

Regulatory policy has over past administrations been inspired by, and largely implemented through, a linear approach to innovation policy which usually took the form of generic and mostly financial support to specific sectors. This approach worked well in an industrial past that was based on more or less predictable patterns of market demand and economic change; it does not work as well in an era marked by unpredictability where competitiveness depends on the ability to innovate. For instance, as other leading industrial regions across the EU, Piedmont created seven science parks, the highest number in Italy, three of which to this day have active business incubators. However, the results in terms of innovation have fallen below expectations. These problems have been compounded by the fact that innovation policy has lacked mechanisms of policy evaluation and accountability of investment decisions.

The lack of proper evaluation of structural problems has been related to complications from changes in regional governments and occasional shifting of priorities related to regional political pressures. As a result past administrations and regional government institutions have found it difficult to communicate to the wider political and business communities that the economic problems of the automotive sector are not cyclical, and able to be addressed through minor and traditional interventions, but rather structural, which require a more thoroughgoing process of reform and the reconfiguration of traditional business relationships.

Debate has raged over whether the region should place strategic emphasis on new or traditional sectors. The emphasis on new sectors originally stressed the importance of ICT, and more recently other leading economic sectors such as health sciences. It was in this context that the *Torino Wireless* initiative was launched. The key objective was to increase ICT intensity in the traditional sectors of the regional economy while fostering entrepreneurship in new ones. However, the initiative has not been supported by other measures to enhance innovation capacity in traditional sectors or measures to include key stakeholders and especially the SMEs. As a result, the initiative has met with criticism that it was "too late".

These shortcomings in the regulatory framework have become reform priorities for the new regional government that came into office in May 2005. The government has introduced a new Regional Law on Research and Innovation as a means to confront the structural problems of the economy. The Law, identifying policy intervention areas for innovation covering the period 2006-2006, is based on a non-linear, ecosystemic understanding of innovation which relies on dynamic relationships between and across businesses, academic and research institutions, and agencies of the public sector as the key to restructuring and innovation.

Though the Law identifies specific sectors for strategic support, it does not provide financial support to the automotive and ICT sectors. More specifically, the Law introduces revisions with respect to the criteria of financing public interventions, specifically seeking to overhaul the previous practice of generic support funds for different sectors with an emphasis on "technology pull" focusing on market and industrial demand for technology

solutions. Financing is now coupled to technology foresight and encouraging framework conditions favouring deeper collaboration between regional enterprises and the university and research institutions of the region. Most R&D investment will not finance traditional sectors but new "frontier" sectors and different domains such as nanotechnology, innovation in healthcare, etc., and specific competitive technology platforms, ranging from hydrogen energy to intelligent systems, in short, sectors that are likely to be critical for competitiveness in the next ten years.

The central idea that lies behind the four "platforms" and the "frontier" sectors identified by the new Regional Law on Research and Innovation is to increase the innovation potential of regional companies, especially SMEs, by enabling them to reconfigure their competencies and enter new and more technology-intensive sectors and to enable the "migration" of regional firms to higher value added activities, be they in the automotive sector or in other sectors such as transportation and aeronautics. This is an effort to better synchronise the education capabilities of the region with the economic transformations it confronts.

This is the case with the agreement concluded in 2005 among key stakeholders in the automotive cluster to assist SMEs in the sector to diversify their activities toward the more globally oriented aeronautics sector.

However, this "migration" toward higher value added segments of a global value chain depends on good governance. Several key stakeholders interviewed for this report stressed that reform of the governance structure accompanied by education of the stakeholders, especially among the SMEs, are critical to the success of the automotive cluster and the economic future of the region because it plays a decisive role in the implementation of innovation strategy. The regional administration structures continue to be relatively fragmented, largely catering to particular interests, preventing the emergence of a strategic framework that could generate synergies and accelerate adjustment. The region of Piedmont and the city of Turin have been good at generating plans for industrial restructuring, innovation and competitiveness; however, these plans tend to become demobilised due to regional and local political concerns and social networks – which expand across all the levels of the cluster – geared to the preservation of established and vested interests. As one interviewee put it, in the historical context of Piedmont and its institutional and cultural specificities, the key policy issue for governance is to create an environment where each of the key stakeholders maintains autonomy while the *sum total* of their actions contributes to the general strategic development of the region.

However, the new strategic orientation faces significant obstacles of both a structural and socio-political nature. For instance, Italy's spending on R&D is 1.1% of GDP, which is the lowest in comparison with other advanced economies of the EU. In addition, in Piedmont the balance between private and public investment on R&D is heavily tilted toward the latter. In addition, the new priorities and the financial instruments earmarked to support them face opposition from the automotive and aeronautics sectors.

Despite the shift away from generic support to the automotive sector, the regional government has actively intervened to assist the process of adjustment and innovation. For instance, *Finpiemonte* has bought 1 million m^2 of the 3 million m^2 of the old Fiat factory in Turin, on condition that the new Fiat popular model Punto would be built in the city. The new venture will be based on a new approach – a new model involving research, suppliers and public institutions – geared to innovation. The overriding policy direction of the government in this respect is to build synergies between designers and new production

methods. This orientation reflects a wider understanding that the region faces a structural problem which needs long-term solutions.

General conclusion

The Piedmont region and the automotive cluster in and around Turin have faced great disruption over the past 10 years and continue to face strategic challenges with a potentially decisive impact on the entire economy of the region. The case presented here highlights several key points.

- The region and the automotive cluster are keenly aware of the changes associated with European integration and the euro, globalisation and the heightened competitive pressures stemming from the emergence of new economic powers.
- The regional players are also aware of the challenges and the potential for Turin associated with the transition from production to services and specifically in the automotive sector the transition of value added to the design and advanced engineering phases of automobile production.
- Though at first sight the strategy of the Piedmont region appears fragmented and loosely-structured there is a certain logic that connects its different components. The central idea that lies behind the four "platforms" and the "frontier" sectors identified by the new Regional Law on Research and Innovation is to increase the innovation potential of regional companies, especially SMEs, by enabling them to reconfigure their competencies and enter new and more technology-intensive sectors. Indeed, this is the case with the Agreement concluded in 2005 among key stakeholders in the automotive cluster to assist SMEs in the sector to diversify their activities toward the more globally oriented aeronautics sector.
- Today, car design is one of the "frontier" sectors within the automotive industry in Turin and not only linked to Fiat. There is a general tendency for going into more high value added production and services such as design and info-automotive among SMEs within the region. In the past, the prevailing relationships between Fiat and its component supplier SMEs, based as they were on a one-to-one basis, left SMEs concentrating in low value added activities which resulted in few possibilities for internationalisation. The new approach seeks to reverse this by increasing technological sophistication and innovation, and hence the international potential, of SMEs.
- However, a key condition for the development of successful adjustment and innovation strategy is the accurate assessment of the structural realities of the region.
- The new Regional Law on Research and Innovation addresses some of the critical shortcomings of the previous innovation policy regime, especially through a new understanding of innovation dynamics it introduces, along with a rigorous methodology and assessment criteria for public interventions, technology foresight for emerging sectors.
- However, though the region has been good at developing advanced plans for innovation and competitiveness it confronts major challenges in terms of implementation. A critical issue concerns reform of the governance system which tends to undermine planned actions and objectives due to regional and local political considerations.
- A crucial issue for regional government authorities in the region remains the communication of the "structural" nature of the economic problems of the region and

the construction of a more inclusive governance structure that includes SMEs in both leading research projects and access to financing through greater transparency and symmetry of information between venture capital and SMEs.

- At first sight the strategic response of Turin to the challenges of the automotive sector appears loosely organised, lacking an overall cohesive framework. However, it is arguable that this looseness is also a factor of strength as it contributes to flexibility. The historical context of the region and its institutional and political make-up have contributed to a framework response that connects the different stakeholders of the cluster through tentative agreements of collaboration and to the extent that they contribute to the promotion of particular interests. However, the relative fragmentation of the policy responses has inhibited the development of a widely accepted and coherent strategic response. The policy challenge from a regional policy perspective is how to allow for independence of action among the different stakeholders (the politically acceptable) while positioning such independence to contribute to the development of the region (the politically necessary).

Detroit/south-east Michigan, USA

Introduction and basic data about the region

Perhaps no other region in the industrial world has been identified more closely with automotive production during the 20th century than south-east Michigan, and more specifically the area surrounding the city of Detroit. It was here that the methods that dominated automotive production for much of the 20th century, above all Fordism, were invented and deployed to unprecedented scale and impact. It is also here that the historic challenges that confront the automotive industry in the opening decades of the 21st century can be observed in their most acute form.

Michigan is part of the Great Lakes Region of the United States. The region is an economic, social and cultural area comprising 12 states, including the western portions of New York, Pennsylvania, and West Virginia, northern Kentucky, all of Ohio, Indiana, Michigan, Illinois, and Wisconsin, and eastern Minnesota, Iowa and Missouri. It is one of the largest industrial production centres and marketplaces in the world. It is also a vital centre of economic activity and growth in the industrial heartland of the United States.

South-east Michigan has a population of 4.9 million people. However, the economic footprint of the automotive industry of the region extends beyond the geographical perimeter of south-east Michigan and the city of Detroit. Automobile production, including automotive components production, extends into a larger area, involving people and communities across the state but also surrounding states and southern Ontario. The region is also a central hub for international trade as 42% of US-Canada trade passes through the Detroit/Windsor and Flint/Sarnia corridors.

Being part of the US federal system, the administrative structure of Michigan is organised at state and county levels. The region's administration includes several counties which connect local government units and state-level governance structures and processes. Given its centrality in automotive production, the region has a rich history of industrial organisation and syndicalism, closely associated with the history of the United Auto Workers (UAW) and Democratic party-political affiliations. This socio-political and institutional compact has been the foundation of the economic dynamism of the region

and the historic compromises between automobile manufacturers and organised labour that defined automobile production in the United States for most of the 20th century.

Yet, despite its illustrious economic history and dynamism of the past, the region is today facing an uncertain future. Globalisation and transformations in the automotive production process, coupled to intense competition from other states within the United States and emerging economies, have diminished the region's economic primacy, leaving its economy and communities struggling to redefine their competitive niche. With one foot in a declining economic base, and the other in the emerging global knowledge economy, the region is facing two scenarios: a future marked by growth and innovation, and one that conforms to the prospect of long-term industrial decline and relegation to a "Rust Belt" of the industrial past (The Brooking Institution Metropolitan Program, 2006).

South-east Michigan today confronts challenges which in some ways are historical reversals of the amalgam of the social, economic and political conditions that underpinned its ascendance as a pre-eminent automobile production location. The region is heavily reliant on mature industries and product lines, an ageing population that lacks the education and skills required to generate new economy activities, and a political and institutional/administrative structure that is not equipped to address the challenges the region faces.

In contrast to the historical experience of much of the last century, the region's metropolitan areas are economically stagnant, engaged mostly in traditional economic activities that face serious competition from other states in the United States and emerging economies. It also lags in entrepreneurial spirit, which is undermining its ability to generate new firms and employment in high-value knowledge-intensive industries. These conditions are compounded by a historical legacy of employee benefits, job and income security programmes, negotiated during earlier decades of growth, which have become a burden, putting the region's firms at a disadvantage in the global economy.

To gain perspective of the scale of transformation across the region it is worth noting that from 1995 to 2000 Michigan lost over 16 000 of its young, talented workers, while its workforce is growing older. One of the main reasons for this is that the region has not created enough jobs in knowledge-intensive, high value added services industries to offset declines in industrial jobs, while it has struggled to commercialise the outcomes of its research and innovations. As a result the region must continue to make rapid productivity gains in manufacturing while at the same time developing new products from its industrial base, and new knowledge-based products and services.

Yet, the measures necessary for improving the region's economic prospects are conditioned by the structures of its industrial past. The region's economy is dominated by the automotive industry which has provided a century of prosperity, punctuated by occasional periods of economic downturn. The domestic manufacturer presence, despite decades of downsizing, still makes Michigan the most concentrated automobile manufacturing state in the United States. Automobiles and light trucks manufactured by Ford, GM, and Daimler-Chrysler are critical to the region's economy. However, the "Big 3" manufacturers have been losing market share for years. This loss is related to an increasingly competitive international environment with global automobile manufacturers striving for market share and profitability.

Unlike past downturns, which were often followed by upswings for the domestic automotive industry, and hence good times for south-east Michigan, the prospect of a turnaround today hinges in a fundamental sense on the sector's ability to halt and reverse the loss in market share by the domestic manufacturers. Interviews conducted for this study indicate that there is no confidence in the prospect of a quick turnaround.

The loss in market share is not a cyclical phenomenon. The automotive industry is facing a structural change. According to seasoned estimates the industry is not likely to regain the position it held during the 1950-60s. The region has been recovering from the recession of the 1980-90s. However, during these downturns it was mainly domestic US automotive manufacturers that lost market share to foreign manufacturers. Indeed, the domestic downturn in 2001 was due to changing market preferences, the cost of production, and investment decisions in new manufacturing locations in other states.

According to official statistics the two sectors with the largest losses of employment are automobile and automotive components manufacturing. Old-style retail sub-sectors also figure prominently in the statistics regarding loss of employment, perhaps reflecting multiplier effects. Another sector that has been affected by the structural change of the automotive sector is public services, generally inclusive of federal, state, and local governments. The loss of industrial capacity in the manufacturing sector has constrained public budgets across Michigan resulting in public sector layoffs. This is the core of the problem for the regional economy: its major industry is not in a transitional recession, it is in a fight for survival, while its regional policy framework is not equipped to provide it with the necessary support mechanisms.

Despite the enormous impact of the changes affecting the automotive industry, the economy of south-east Michigan is also experiencing growth in a number of sectors considered to be part of an emerging new economy. The automotive industry is undergoing dramatic restructuring and continues to shed factory employment. Yet, the region is emerging as a global automotive design and research centre. While some new foreign transplant manufacturers are locating production facilities in southern states of the United States, some highly competitive automobile manufacturers, such as Toyota and Honda, are investing in new facilities and R&D centres in south-east Michigan, but also in states like Indiana and Ohio.

The region is also hosting significant R&D activities in the field of biotechnology. The Great Lakes Region is home to some of the United States' leading centres of medical research, teaching, and treatment, with a number of highly-ranked hospitals in multiple disciplines. In addition, metropolitan areas like Detroit/Ann Arbor, Chicago, and St Louis, are among the top-ranked biotechnology research centres in the country. However, these are sectors that require generally higher levels of education than those typically required for automotive manufacturing.

South-east Michigan's economy is undergoing a historic transformation that has undermined the competitiveness of its major companies. The region cannot regain its dynamism until one or both of two conditions are met: these companies return to prominence and drive the region's economy, or, they at least reach a state of equilibrium that halts the loss of market share. Such equilibrium will arrest the loss of industrial capacity and facilitate growth in the emerging new economy sectors to create employment growth in the total economy of the state (The Brooking Institution Metropolitan Program, 2006).

The automotive sector in Detroit/south-east Michigan

The state of the US automotive industry today is marked by contradictory tendencies. A set of positive trends is making the overall industry appear robust. At the same time, some negative trends reflect serious weaknesses. Growth in light vehicle sales has been on a downward trend for the last 25 years, and fell below 1.5% per year in 2000. The continuing losses of market share by GM and Ford have been reflected in gains by their foreign competitors. According to some, the US light vehicle market was an oligopoly prior to the late 1990s, which meant that US manufacturers could earn above-normal returns. The market now seems to be directed toward a more competitive position with manufacturers roughly equal in size. It is a distinct possibility that the EU's market composition, where the largest player commands less than 20% share, may be the prospect that the US automotive industry is facing.

Some of the contradictory tendencies in the US automotive industry are outlined below:

- The volume of light vehicles sold annually is impressive by historical standards. Unit sales have not been less than 16 million since 1998; they have not been less than 15 million since 1993. Yet, this volume has been sustained through substantial price reductions.
- The competitive structure of the industry is changing, and appears to be heading toward a situation where six or seven more roughly-equal manufacturers struggle for market share.
- After two decades of historically low oil prices, expectations now are of rising prices for the next two decades.
- GM, Ford and Daimler-Chrysler have relied on truck-based SUVs for much of their profits for many years. They now face serious risks as higher oil prices and environmental awareness drive consumers away from SUVs and toward crossovers and cars.
- GM, Ford and Daimler-Chrysler have a significant cost disadvantage, most of which can be attributed to legacy issues (union agreements and pension liabilities, coupled to a large retiree population);
- GM and Daimler-Chrysler have been reluctant to embrace hybrid technologies, while Toyota, Honda and Ford have commercialised them. As the market moves toward general acceptance of such technologies, GM and Daimler-Chrysler face uncertainty.
- The Great Lakes Region's share of the US motor vehicles and components manufacturing employment has been in long-term decline since the 1940s. In the last 30 years the pace of decline has accelerated (McManus, 2006).

The global automotive industry has changed dramatically over the last 15 years, which has heightened the competitive pressure facing Detroit. This pressure is mainly related to the development of a "parallel" automotive industry located in states like Ohio, Kentucky, and other southern states of the United States. Several foreign-owned companies have established production facilities there mainly because of the availability of a young, non-unionised workforce. This production process is competing directly with southeast Michigan and suppliers are following the manufacturing companies. This "parallel" internal automotive industry is booming because automotive manufacturers can access a younger workforce outside union collective agreements, with no legacy costs or pension liabilities.

Another major factor that affects the industry is demographics. As the baby boomer generation begins to approach retirement age it has created a "boomer shock". This is reflected in skilled-labour shortages and intensified competition for access to and hiring of talent. Indeed the availability of a skilled industrial labour supply is a major issue across the industry. As part of a short-term solution, automotive manufacturers are offering inducements for workers close to retirement age to work longer. Part of a longer-term solution is immigration. Despite popular misperceptions, immigrants to the region are relatively well-educated compared to immigrants nationwide. On average, 36% or more of the foreign-born population in Michigan hold a bachelor's degree (compared to a national average of 27%) (The Brooking Institution Metropolitan Program, 2006).

But there are also changes in the car-making philosophy of US manufacturers. Since the closing decades of the 20th century they have become truck manufacturers. They have let the car segments of their product lines languish. Indeed, the growth of the truck segment of the market – which was facilitated by cheap oil prices – was interpreted as a return to the good old times. Meanwhile, foreign manufacturers, such as Toyota and Honda, caught up. Given their success, the trend is back toward cars and crossovers.

Apart from these endogenous changes in the United States, the automotive industry is affected by global production and market shifts and the emergence of new economies. For most of the 20th century the United States dominated the automotive economy both in terms of production and consumption. It is still the largest market in the world. However, the enlargement of the EU and the emergence of new economic powers, such as China and India, have transformed the global automotive industry, both in its market composition and production topology. These regions are emerging as major locations for the production and sale of automobiles. Given the prevailing and anticipated cost differentials and market preferences this is changing product lines of global automotive firms and the calculus of their location investment decisions. Against a secular loss of market share in the US market, the key strategic question for US manufacturers is whether they can compensate in other parts of the world.

Against this background, US manufacturers are seeking to form strategic alliances with top engineering schools in China and India. To maintain market share in non-competitive areas they need to find partners both in the production and R&D domains. For instance, Ford has several alliances with leading schools in China to capture some of the intellectual capacity in the higher end of the value chain. This reflects the weaknesses of the US education system, especially in the middle levels of applied sciences, even though the upper echelons of the research centres of south-east Michigan are world leaders. Yet, the emergence of China has not had an impact yet on US manufacturers. Instead, the major driver of change in the industry has been the development of a "parallel" automotive industry which is largely foreign-owned, non-union and more flexible, and is not burdened by the legacy costs of US manufacturers.

This drive for access to international pools of skill and knowledge is related to technological transformations within the automotive industry itself, but also to the wider application of information and communication technologies (ICT) in the process of design and product development. For instance, ICT allows for the formation of transnational networks of engineers which facilitates the transition from physical to virtual prototyping of technology (reducing development times by up to 80%) and product development

timeframes reducing from five to two years. Even though intellectual property rights protection remains an issue the trend is toward virtual prototyping.

Thus, looking at the global automotive industry there are different strengths embedded in different regions. No region has a monopoly on the "high end". In fact, seasoned opinion in the industry speaks of a "flat world" in which global networks of automobile production enable companies to assemble engineering teams regardless of location. According to interviews conducted for this study, future success in the industry will be decided on the relative capacity of automotive manufacturers to manage their global assets.

However, this production topology tends to favour different corporate structures which place US automotive manufacturers at a disadvantage. US manufacturers, such as GM and Ford, have historically been built from different parts, brands and identities. Operating in a global "flat world" exposes them to problems of co-ordination and alignments of design and product development with global market trends. Japanese manufacturers such as Toyota and Honda, by contrast, have grown organically – from a centre outward – with a single identity which gives them the ability to adapt faster to global market and industrial shifts.

It is this set of factors that accounts for the reduction of the commitment of the "Big 3" US automotive manufacturers to producing automobiles in south-east Michigan. Their response to the loss of market share – especially by companies that produce automobiles in the US – legacy costs, and the associated search for cost efficiencies, has been to delocalise on a large scale, primarily toward other regions within the United States but also increasingly to international locations. Reduced commitment on their part to the future of the region has also come to mean reduced support for the development of its economic infrastructure, including its educational system, even though the sector continues to rely on research conducted in the region.

For regional government authorities, though the region's dependence on the sector remains high, the challenge is how to organise a strategic response to the loss of industrial strength and employment through the improvement of the education system and diversification of the regional economic base toward new economic sectors. It is characteristic of the scale of the change in the automotive industry in Michigan that during interviews, experts on the automotive industry remarked that automotive production in Detroit will cease altogether within the next 10 years.

Regional governance and strategies

South-east Michigan has experienced massive delocalisation of the automotive industry, presenting historic challenges for the region and the state of Michigan. Despite the scale of the challenges the sector faces, the US Administration has not responded with any measures of support (with the possible exception of currency policy). As for the regional government, the response so far has been of an *ad hoc* nature involving specific but largely disconnected initiatives rather than of a strategic nature in the sense of seeking to establish framework conditions for the protection and promotion of the sector.

Apart from the short-term political factors which account for this (Michigan being a Democratic state, the US Administration being Republican), the nature of the institutional response to the challenges Detroit faces has roots in US history which does not encourage overt framework intervention in the regulation of economic affairs. As a result, the region

is confronting a secular trend of deindustrialisation (largely through the delocalisation of the automotive industry), while lacking the political and institutional means to mount a policy response to confront it.

Against the background of these massive shifts, south-east Michigan and Detroit have attempted to ignore the fact that these changes are structural and permanent – not cyclical and ephemeral. Indeed, much of the policy discourse and the approaches to confronting the changes are marked by nostalgia and the belief that the region and the industry can return to the glory days of the 1950-60s. Short-term perspectives prevail.

Given the industrial history of the United States and the prevailing approaches to intervention in the economy, most of the responses to the crisis and transformation of the automotive sector in Michigan have been *ad hoc*. The region has responded with several initiatives and there are several strategies in the non-profit sector. However, there is no overall regional strategy. Political priorities attached to electoral politics militate against public admission that the current crisis of the industry is a structural one. Interviews conducted for this study revealed a certain desire for a "New Deal" approach. However, at the same time, they indicated scepticism that such an approach would be forthcoming. As it stands, the region has no institutional structure that frames strategy. The responses of the automotive industry are mostly through *ad hoc* networking.

Various responses seek to promote the competitiveness of the region internally, through the co-ordination of capabilities, and externally, through the promotion of the region internationally. The organizing principle of the different initiatives is: the private sector expresses their needs; the regional public sector helps with the implementation. The sources of the different responses are as follows.

Detroit Renaissance (see *www.detroitrenaissance.com*) is an initiative structured around a group of CEOs of leading companies who convene to address the development needs of the region. The original focus of the group was on the development of Detroit, especially its downtown core. However, more recently the emphasis has expanded to include three counties – McComb, Oakland and Wayne. This approach centres on Detroit but seeks to capitalise on the interdependencies across the counties. It is based on co-operation and the search for synergies with a strong emphasis on education and the formation of human capital which would help re-establish the region as a key investment location. However, the initiative is composed of different visions which are only loosely structured. As a result, the focus on education is the only common denominator and the glue that holds its different approaches together.

Detroit Regional Economic Partnership (see *www.detroitchamber.com/business_development*) is a group of ten counties hosted by the Detroit Chamber of Commerce, with the objective to develop strategies to attract foreign companies to the region. The group engages in "environmental" investments to attract companies to the region. A major part of its operations involves providing marketing material and carrying out trade missions to promote the region as an investment location and to get companies to relocate operations there.

SEMCOG (see *www.semcog.org*) is an organisation that was originally created to develop planning and co-ordination of business and policy initiatives among 10 countries in order to improve business and regional economic performance. More recently, it focuses most of its activities on workforce quality development initiatives.

Automation Alley (see *www.automationalley.com*) is a technology cluster networking companies linked through technology providing a "brand" separate from Detroit. Its members include organisations from the worlds of business, university and research, and government. The cluster seeks to address some of the concerns of the automotive sector while focussing on synergies across developments in the industry and new economy and knowledge-intensive activities. For instance, the automotive sector has been a magnet for ICT in the region. The organisation has conducted a quantitative mapping study to determine the areas of strength of south-east Michigan. Its emphasis is on education, especially in middle levels of applied sciences and the development of new skills in advanced applications within the automotive sector, but also in emerging sectors. As such *Automation Alley* functions as a nodal point for the development of key competencies and their networking on a cross-sector regional basis.

Examples of state-level strategies include business retention programmes, tools for generating employment and tax credits against the single business tax. The *21st Century Jobs Fund* concentrates on Advanced Manufacturing, Advanced Automotive, Homeland Security and Biomedical, which have been identified as strategic priorities for the development of the state. Technology transfer is a key priority: moving from concept to product to market. In each of the above initiatives leading people from each sit on each other's organisation's boards in order to ensure coherence and avoid duplication.

There are also initiatives at the county level. For instance, Macomb county is seeking to align its regional capabilities with emerging new economy activities. The county is focusing on advanced manufacturing, alternative energy and health care as key sectors that will drive future growth. It has divided its set of priorities into four subcategories: business development, workforce development, transportation and quality of life. With respect to the automotive sector the emphasis is on high value added activities such as lean manufacturing with advanced engineering skills and high-wage employment. The objective is to attract advanced portions of the automotive manufacturing process to the region and embed them into its existing R&D and manufacturing capabilities.

Wayne county, as the site of the Detroit Willow Run airport, in collaboration with international players such as Schiphol and Beijing, has been active in developing a logistics cluster around the airport. The objective of this initiative is to place Detroit in a position to guarantee delivery of products to and from anywhere in the world within 12 hours. In addition, Detroit is a junction point for several main freeways, such as the one connecting Montreal to Mexico City, which offer further benefits in terms of commercial traffic volume. The goal is to build Detroit into a global logistics centre. In terms of regional policy support, Wayne county has been the initiator. It has bought 2 000 acres of land for future expansion, as well as ensuring a federal grant of USD 100 million. The initiative has been co-ordinated with other local counties and the "Big 3" automotive manufacturers own a significant amount of land on which the project will be built. In terms of the financial plan for its completion the project will rely on public as well as private funds.

As is the case of the overall economic strategy of the region, there is no clearly defined strategy for the automotive sector. This is partly a function of the absence of an institutional strategic framework that can give coherence to different initiatives, partly of the prevailing nostalgia for the past. According to interviews conducted for this study, this amounts to a collective incapacity to face the truth. As a result, the initiatives to address the challenges confronting the automotive sector are largely *ad hoc*.

In terms of its regional industrial ecology the automotive sector is a magnet for other advanced technologies such as ICT, alternative energy research, and logistics, among others. However, there is an absence of mechanisms for technology transfer from the automotive sector, itself a major integrating force of advanced technologies, and technologies and innovations developed in the sector, to other industries. For instance, though there are sophisticated channels for technology transfer from research related to the military to automotive production, with significant federal government support, the results have been only moderately successful.

Given the current economic disruptions in south-east Michigan associated with the automotive industry, explorations are underway to assist the economy of the region to make the transition to the new economy. Regional policy-making institutions and leading academic and research institutions have reflected on the industrial history of the region and the factors that enabled the emergence of the automobile industry there. The pre-automotive regional industrial structure had elements that could be transformed relatively easily into automotive-related skills and processes. The region at the turn of the 20th century had already a cottage industry specialising in industrial ovens, tool making and shipbuilding, which allowed for a relatively easy transition to automobile manufacturing. In addition, the assembly line invented by Ford was precisely designed to simplify production tasks, which allowed for the integration of large amounts of immigrant workers of relatively modest skill levels into the production process, and after World War II generated unprecedented wage earnings.

However, there are great difficulties and discontinuities in trying to make the transition from an automotive economic base to advanced technologies such as ICT, biotech and health. The skills that are required for automotive production today cannot be easily reconfigured for adaptation to the needs of new sectors such as biotechnology, health sciences or ICT. It is obvious that such retraining requires a targeted educational and labour policy intervention.

It is here that the significance of education bears its full weight. Michigan is home to some of the top educational and research facilities in the United States. However, the university and training system is not fully in line with the demands of the automotive industry. According to interviews conducted for this study one of the major factors behind this is the tenure system which insulates university departments, professors and researchers from market pressures. At lower educational levels the challenges are even greater. For instance, the city of Detroit has a dropout rate of approximately 50% which is related to the fact that Michigan has one of the lowest rates of college education in the United States. Educational reform, especially of the middle levels is a critical issue. The economic activities the region is targeting require analytical skills, math skills, computer literacy, and the flexibility to develop new skills.

However, as in the case of policy design, the past weighs heavy on educational reform. Fordism was about the simplification and sequencing of tasks into the assembly line, which did not require advanced levels of education. The golden age that followed World War II helped consolidate a culture not particularly open to higher education, as young people of relatively modest education could achieve standards of living that became the envy of the world. It is this culture that has come under most pressure today given the significantly higher skill demands from automotive manufacturers and other advanced industries the region considers critical to its future. Part of addressing this issue would be

public funds. However, public budgets are constrained given the shrinking tax base of the state. Another part would be support from the "Big 3" automotive manufacturers. However, given their location strategies in the "parallel" automotive industry across the United States and the gravitational pull of globalisation, they have significantly reduced their commitment to the economic development of the region.

The impact of these factors is closely related to the region's stagnating entrepreneurialism. As recent research on the subject shows, this is likely the result of several conditions. Entrepreneurs are normally educated and more likely to be long-term community residents. Low overall levels of education in the region and the continuing out-migration of young, educated people could thus be hindering the development of new enterprises. On the other hand, some of the failure to commercialise new knowledge may be due to failures in venture capital markets, as these tend to have their investments in close proximity. Another factor, related to the attitude toward education, might be the change-averse culture that has been nurtured through several generations of industrial employment and general prosperity (The Brooking Institution Metropolitan Program, 2006). In this respect, as much as in the importation of skills, the region relies on immigration.

The region, with the assistance of regional government, has begun to diversify its economic base, especially toward new economy industries such as biotechnology, health science, and ICT. However, given the weaknesses of the educational system, especially in its middle levels geared to applied sciences, the development of skills critical to both leading technological fields in the automotive industry itself and emerging new economy sectors, the region confronts significant challenges. Leading manufacturers in the region have raised major concerns that the automotive sector faces significant skill shortages.

Detroit is perhaps the best reflection of the geographical dispersion of the automotive production process. The Detroit cluster remains vertically integrated with respect to the production of components, even as the major manufacturers have delocalized their operations into other states. However, relentless pressures to shorten product development and production cycles, coupled to the introduction of advanced technologies, enable functions such as advanced engineering and design to be performed through virtual networks. These allow access to knowledge and expertise on a global basis while they considerably lessen the reliance of manufacturers on the regional location in which they have been historically built. Given the shortcomings of the regional education system, this drive for access to global pools of skill and competence has taken on added significance for US manufacturers. Indeed, competitiveness in the automotive sector has come to depend to a large extent on how manufacturers can leverage their global, not regional, assets.

"Clusters" and "cluster policies" remain generic terms. The case of Detroit indicates that there are significant differences in the organisational network topology of clusters. These are related to the industrial sectors in which clusters operate, but especially the technology- and knowledge-intensive, and value added elements they undertake. Though some clusters are embedded in geographical locations (requiring more traditional forms of intervention and support) others operate as "hubs" in geographically dispersed but technologically, organisationally and institutionally integrated networks. In other words, regional "clusters" need to be thought of both in traditional terms – embedded in a geographical context, *i.e.*, regions – and within a globally defined value chain.

Consequently, cluster policy must be designed according to the organisational and operational topology of different clusters and their precise location in the production process and value chain. Clusters specialising in the supply of components might require co-ordination mechanisms among collocated key stakeholders. Clusters engaging in design and other high value added activities are increasingly organised as "hubs" within geographically dispersed networks of knowledge flows. For these, policy should support the development of global approaches and mechanisms which insert the competences and requirements of the regional cluster into global circuits of knowledge and expertise.

Cluster policy in south-east Michigan is also marked by the absence of synchronisation with developments in the region's economic base. The diminishing commitment of the "Big 3" automotive manufacturers has come with a weakening commitment to the infrastructural development of the region reflected in the decline of downtown Detroit, now coupled to mounting racial tensions between the city and surrounding areas. At the same time, the historical weight of the glory days that lasted for the better part of the 20th century have left a cultural legacy where the problems of the automotive sector are seen as cyclical, short-term, and reversible. This problem is compounded by the general sceptical attitude toward education and change-aversion. The continuing inability to generate a strategic response to the challenges the region faces leaves room only for *ad hoc* responses which are neither able to confront the secular loss of industrial strength, nor to diversify the regional economy and reduce the vulnerability of the region.

General conclusion

South-east Michigan and its automotive cluster yield a number of lessons regarding regional economic policy and cluster support. These can be summarised as follows:

- Despite its dynamic economic history of the past the region is today facing an uncertain future. Globalisation and structural changes in the automotive production process, coupled to intense competition from other states within the United States and emerging economies, have challenged the region's economic primacy. The region today is facing two scenarios: a future marked by innovation that enables the transition to a new knowledge-based high value added economy, and one of long term deindustrialisation and decline.
- Despite the massive transformations in the regions' economy which continues to be dominated by the automotive sector, the region has not been able to develop a strategic response to address the crisis. This is the crux of the problem for south-east Michigan's economy: its major industry finds itself in a struggle for survival, while its regional policy framework is not equipped to provide it with the necessary support mechanisms. Given the prevailing approaches to intervention in the economy, most of the responses to the crisis and transformation of the automotive sector in Michigan have been *ad hoc*. This is partly a function of the absence of an institutional strategic framework that can give coherence to different initiatives, partly of the prevailing nostalgia for the past.
- The region's economy has begun a process of diversification into new economy fields such as biotechnology, ICT and health science. However, it confronts significant challenges in developing the relevant skills or reconfiguring existing skills and adapting them to the requirements of these sectors. The solution would be targeted intervention to strengthen educational skills, especially in middle levels of applied sciences.

- However, education is not a panacea. The case of south-east Michigan demonstrates the importance of regional policy frameworks for changes affecting the regional economy. This is not only an issue of policy design and alignment. It depends in a fundamental sense on the existence of strategic and flexible institutional frameworks with capacities to anticipate change and intervene strategically to open paths toward new economic activities and restructuring of existing ones. It is also connected to the dependence on, and commitment to, the development of the region on the part of the dominant economic players. Neither of these conditions is present in south-east Michigan.

Based on the foregoing analysis the following may be advanced:

- Several challenges south-east Michigan faces are related to the diminishing commitment of the three major automotive manufacturers to the region. Though it is likely that the loss of automotive manufacturing is a secular trend, the region has strengths in high value added economic activities such as design. As a result, emphasis should be on the development of regional capabilities to attract and retain these portions of the production process.
- The automotive sector is a magnet as well as an integrator of other advanced technologies such as ICT. It is also a generator of major innovations. A policy priority should be to improve technology transfer across sectors in ways that build synergies and competitiveness.
- The intensive application of technology in the automotive production process alters the topology of clusters. Component supply clusters tend to be vertically integrated and geographically collocated. Advanced engineering, design and other knowledge-intensive functions, as the case of south-east Michigan illustrates, tend to be ICT-enabled and networked on a geographically dispersed basis. As a result, cluster policy must be targeted according to the knowledge intensity and topology of different clusters within the automotive production process.
- A positive aspect in the case of south-east Michigan is the growing diversification of the region's economy. However, the existing fragmentation of the institutional frameworks allows only for *ad hoc* responses and hinders the co-ordination of policy actions necessary for support in the transition to new economy activities. As a result, institutional reform with emphasis on the development of a common strategy involving all the key stakeholders should be a priority for the regional authorities.
- One of the outstanding features of south-east Michigan concerns the role of education in the process of economic restructuring. Michigan has significant R&D capabilities and some of the top educational facilities in the United States. However, its major weakness is in the middle levels of education in applied sciences which are critical for employment in advanced manufacturing and production activities. Educational reform with an emphasis on strengthening this segment should be a key priority.
- However, education is not a solution to all the economic problems that the region faces. Education and training must be embedded in broader strategies of aligning education to the needs of the economic base of the region, continuous labour training and employment schemes and inclusive social policies, which by definition demonstrate the commitment of a region to long-term economic and social development. In the absence of such a framework, continuous repetition of the importance of education simply lacks credibility.

Shanghai, China

Introduction and basic data about the region

Shanghai is the largest city in the People's Republic of China and the eighth-largest in the world. The 2000 census put the population at 17 million, including the non-official resident (floating) population of almost 4 million. Shanghai is now an international financial hub and a major destination for corporate headquarters. It is the third-busiest port in the world, following Singapore and Hong Kong, China. It recorded double-digit growth for 14 consecutive years since 1992. In 2005, Shanghai's nominal GDP experienced 11.1% growth to CNY 912.5 billion (approximately EUR 95 billion). The "pillar industries" which account for the majority of its gross regional product (GRP) include microelectronics, automotive, fine chemistry, high-quality steel, machinery and shipbuilding. It also includes prominent ICT, biotechnology and pharmaceuticals, and financial services sectors.

Administratively, Shanghai is a municipality that has province-level status. The municipality oversees 19 districts which are further subdivided into counties. Within the provincial government, the Shanghai Municipal Development and Reform Commission has a very broad mandate to lead economic and social development, in line with national-level goals. The Science and Technology Commission serves an important role in orienting science and technology policy as well as financing R&D and developing platforms to support the technology needs of different actors and sectors.

Shanghai possesses a number of important assets to support innovation. On many indicators, it is in fact the highest-performing region in the country (CITE RIS REPORT). For example, public R&D investment in the region has grown rapidly, from 1.78% in 2001 to 2.34% of GRP in 2005 (STCSM), albeit with a focus on basic and early stages. A number of the most prominent industrial parks, development zones and universities are located in or near Shanghai (Fudan University, Nanjing University, China Science and Technology University, Zhejiang University and Shanghai Jiaotong University). Central government policy has been a major driver behind the concentration of these resources in certain regions. It is expected that Shanghai and the rest of the Yangtze River Delta area, along with the two other major growth poles of the Pearl River Delta and the Bo Hai Rim, will drive China's high-tech industrialisation.

The automotive sector in Shanghai

When China decided to open its economy to market reforms by designating "special economic zones" and "open cities" to attract FDI, Shanghai was not included. The city was considered the core of the industrial structure of the country and as such not an appropriate target for economic experimentation. This decision was reversed in the 1990s when the central government opened the city to FDI. As part of this decision the government offered special support to international firms that established operations in the Pudong New Area, an area which until then was an agricultural zone. The automotive industry was selected as one of the "pillar industries" to shape the future development of the city. After the financial crisis in Asia, the municipal government strengthened its support of the manufacturing industry and postponed plans to focus on the financial and trade sectors.

The origins of the automotive industry in China can be traced to 1958 when the first car was designed in Shanghai. However, the origins of the automotive cluster are located in the early 1980s when the central government approved the production of automotive spare

parts for VW which came to be organised around the Shanghai Automotive Industrial Corporation (SAIC), on land provided by the Municipality of Shanghai. With the objective to bring the national automobile industry up to international standards and avoid having to import automobiles on a large scale, the central government had started negotiations with VW already in 1978. These resulted in a joint venture between SAIC, the Bank of China, the China National Automotive Industrial Corporation (the parent organisation of the Chinese automobile industry) and VW.

The joint venture, which was called Shanghai Volkswagen (SVW), started to produce the *VW Santana* in 1985. In its first years of production, SVW still imported most parts and components needed for local production from abroad. At that time, there were no firms within the region that could have supplied parts in required levels of quantity and quality. At the same time, for the German suppliers of VW the volume of *Santanas* produced in Shanghai in the 1980s was too low to establish production facilities in China. In 1990, for instance, SVW assembled less than 20 000 vehicles (Depner and Bathelt, 2003).

In an effort to increase local content in production the Chinese government in the late 1980s threatened to enforce a production limit on SVW. The objective of this measure was to stimulate the diffusion of automotive manufacturing competencies across the Shanghai region and integrate regional suppliers in the production process instead of having the cluster function as an importer and assembler of foreign components. In response, SVW enrolled Chinese parts producers, which at the time were largely state-owned enterprises (SOEs) into the production process.

The municipality played a key role in organising the involvement of SOEs which co-operated with foreign manufacturers in the initial phases of the cluster's formation. It also played a supportive role in shaping market conditions by increasing car prices by 16% and by providing low-interest loans to local suppliers. Furthermore, the municipality introduced a regulation requiring that all taxis in Shanghai had to be *Santanas*. In 1991, many of the parts producers had already been integrated into the SAIC group. The cluster got further support when VW demanded that some of its German suppliers establish production facilities in the region. As a consequence, the vertical cluster dimension involving automobile manufacturers and suppliers developed rapidly.

The resulting automotive supplier network is one of the most advanced in China. The SAIC group is the dominant Chinese player in the Shanghai automotive industry. As the group is largely state-owned, with the majority of its shares being controlled by the city of Shanghai, SAIC is closely connected with and supported by the city's policy makers. This does not mean, however, that SAIC is an entity linked to the old era of state monopolies. SAIC is a group made up of different companies which manufacture cars, trucks, busses and motorcycles, as well as automotive components and equipment. By the end of 2001, the group had established 55 joint ventures with other automobile and component manufacturers and employed almost 62 000 people.

As a leading automotive manufacturer in China, SAIC has a vision to also become competitive at an international level. The group has recently expanded its operations beyond Shanghai and holds majority shares of the Liuzhou Wuling Automotive Company and Jiangsu Yizheng Automotive Company, as well as shares of Anhui Chery. In 2002, SAIC acquired a 10% stake in GM's South Korean operations (Depner and Bathelt, 2003). Reflecting the extended cluster's production capabilities, SAIC expects an annual group production of 1.5 million vehicles by the end of 2007.

However, as the cluster was established and operations gained maturity the role of the government also changed from being directive to "steering" by regulating the structure of incentives for the cluster stakeholders. The later phases of growth of the cluster have been supported by different policies of the municipal authorities, such as infrastructure development, labour market reforms and targeted industrial policies (Depner and Bathelt, 2003).

Regional governance and strategies

The evolving transformation of the China's economic and administrative structures depends on the ability to learn from the policies and implementation of initiatives being successively launched by government agencies, and ensure that this learning is applied to the formulation of new policies and better targeting of current ones. Such mechanisms of learning and adjustment in turn depend on the generation, dissemination and application of policy-relevant knowledge. Such learning in the domains of regional economic policy stems largely from two sources: from international experiences and from experimentation within the transition process itself. It is this learning process that frames the launching of objectives and serves as a framework within which policies and priorities are assessed, adjusted and implemented.

In the process of the transition to a market economy the central government and the municipality of Shanghai have placed great importance on the high-tech sector to support export-led development. However, there are several issues that adversely affect the development of regional economic policy. Primary among them is insufficient alignment between technology development goals and economic contribution. This represents a challenge for the existing system governing regional economic policy to the extent that the criteria for assessing priorities related to high-tech development often are not properly aligned with indicators of economic growth. In this respect, as the relationships between the university system and the market suggest, the main challenge for the regional economic system of Shanghai is to develop an innovation system in which project funding decisions are taken in the context of the market, with private enterprises able to engage with the research community and drive regional growth and innovation.

This relative lack of alignment between technological and economic objectives is also linked to a broader problem concerning the prioritisation of R&D targets on a regional basis. In recent efforts toward industrialisation the government has allocated resources for R&D in a top-down manner to ensure investment and development of research in certain strategic but limited technological areas considered critical for catching up with leading international trends. At the same time, most of the state funds for R&D are allocated to universities and research institutes, leaving less for support for R&D in the private sector, particularly among SMEs. The private sector, as interviews conducted for this report revealed, has difficulties in developing and introducing new technologies in areas outside strategic priorities defined at the level of the national government (Remoe, n.d.).

Many observers of China's recent economic development have emphasised that the country is unified by a single party but fragmented as a federal system. The outcome of this is that domestic companies, though benefiting from more or less uniform support stemming from the national economic strategy, are not able to fully access the huge market of the country as they are dependent on regional and local structures of administration. This undermines their ability to develop unique and proprietary technologies targeted to indigenous market needs. This, according to some analysts, has

two major consequences: first, the heavy reliance on FDI up to now means that China's high-tech exports are dominated by foreign companies; second, China's firms that have the scale to compete internationally remain dependent on imported designs of crucial technology components and manufacturing equipment.

These features of the regional economic strategy and the challenges it presents for SMEs were reflected in interviews conducted for this study. For instance, several interviewees stressed the importance of a change of policy direction on two fronts. With respect to the role of government support in the strategy of the cluster, interviews revealed that SMEs would like the government to eliminate policies that are preferential to foreign firms. In particular, they prefer parity on tax rates which are now higher for local and regional firms. They would also like easier access to bank financing which is now rather complicated. For instance to get access to loans through Credit Guarantee Companies (which are state-owned) SMEs have to meet 36 different criteria, which greatly slows down the approval of credit for innovative activities.

In addition, regional firms wish to see changes in labour regulation. Several interviewees pointed to the existing administrative hurdles to the free movement of labour across provinces, which is the result of the residence control system introduced in 1958. For instance, without an official certificate that confirms an individual's residence in Shanghai, prospective employees cannot access employment benefits and welfare, while facing less job security, higher taxes and rent rates. A related issue concerns competition from foreign firms for the attraction of local skilled labour. This leads to the "internationalisation" of wages and working conditions, undermining the cost competitiveness of regional firms. To counter better offers from foreign firms, regional SMEs are forced to offer shares or options to prospective employees, which at least in advanced sectors, avoid the formation of a dual labour market.

Today SAIC collaborates with 60 international companies involved in automotive manufacturing. Since 2003, large international firms have been drawn to Shanghai to reduce costs both in production activities but also increasingly in R&D. Cost pressures are also fueling the transfer of R&D activities to Shanghai, as has been the case with the recent establishment of Delphi, the US automotive components manufacturer, in the region. International firms are also one of the main sources of funds for research involving universities, research institutes and regional firms. As such, international firms constitute a major pillar of the automotive cluster in Shanghai.

However, SAIC is not entirely dependent on FDI through outsourcing, but also to internal market growth dynamics. The rapid development of the car industry in China and the involvement of many Japanese car component manufacturers are forcing some of them to establish product development centres in China to create parts that meet local needs. Indeed, the projection of SAIC to be able to develop 1.5 million vehicles by the end of 2007 is testimony to the region's productive capabilities. Economies of scale have been created through the accumulation of numerous companies within the cluster. Further industrial expansion of component suppliers belonging to different industrial groups will increase competition and reduce procurement costs for auto makers.

Yet, to this day, most activities of SAIC are in applications of solutions developed elsewhere, not high-level prototype research. Expectations are that this will soon change. For instance, in 1995 SAIC made its first inroads into design by participating in the design of the VW *Santana*. With the production of *Santana* a whole production chain has been

formed in Shanghai. Before 1995 all patents belonged to foreign manufacturers; from 1998 SAIC continued its participation in design with the production of the *Passat*. Critical in this respect is the role of Tongji University which hosts the Center for Automotive Engineers. The centre was established two years ago with the aim to develop co-operation between research and industry. R&D activities conducted by Tongji University extend to fuel cell technologies, and power control technologies. In terms of the breakdown of the university's activities in these fields they are organised as follows: application research (whole car making) 100%; future-oriented research (hybrid engines, etc.) 20%; basic research (fuel cell vehicles) 80%.

However, the innovation potential, especially among SMEs in SAIC remains limited due to the one-to-one vertically integrated relationships between automotive manufacturers and component suppliers. Based on interviews conducted for this report, this restricts the options of SMEs with respect to new ventures in innovative activities while it leaves them vulnerable to large international firms in negotiations regarding business priorities. Several interviewees noted that what is critical for the cluster is not attraction of FDI but rather the acquisition of technology and know-how in the international certification of components (this being done until recently by international firms and for which local SMEs feel they "have paid a high price"). This transfer of knowledge to the cluster – which would place it on a par with the leading manufacturers – is a key goal for the cluster stakeholders as it would enable them to open alternative paths toward R&D in leading domains such as alternative energy, environmental engines and advanced engineering, among others.

Another aspect on the strategic horizon of the cluster concerns the horizontal institutionalisation of SMEs. The existing one-to-one vertically integrated relationships between international automotive manufacturers and the SME supplier base does not allow for a horizontal view of the production process, leaving SMEs focused on specific components developed for the needs of the international manufacturers without the ability to develop synergies toward a total and indigenous model of automotive production. Such a horizontal view would require institutional development, specifically the formation of industrial associations responsible for competence development and resource allocation, which would give the cluster stakeholders more influence on the cluster's development.

This approach toward making SAIC relatively independent from particular international firms is reflected in the development of the alliances the group has formed over the past few years. To reduce its dependence on VW and to pressure the group to diversify its production in the region through the introduction of new models and increased technology transfer, SAIC decided to engage in a joint venture with GM. The resulting SGM has since its formation grown to be one of the largest car manufacturers in China. Between 2001 and 2002, for instance, SGM increased its market share in China from 2.7 to 7.7%. The formation of SGM has initiated a number of changes in the product strategy of SVW. The firm now produces several different models in Shanghai; *i.e.*, the *Santana*, *Santana 2000* (a model which was customised for the Brazilian and Chinese markets), *Passat* (since 2000), *Polo* (since 2001) and most recently (since 2002) the *Gol*, which was originally designed for Brazil (Depner and Bathelt, 2003).

At the same time Chinese auto makers such as *Chery*, *Great Wall* and *Geely* have significantly increased their production and market share. For instance, in the first ten months of 2006, 5.8 million cars were sold in China, an increase of 26% over the same

period last year – and Chinese car makers captured 27% of the market, while they will export 75 000 vehicles in 2006 to over 100 countries.

However, there are indications that this rapid pace of development has begun to test the limits of the industry's skills depth. According to the latest China Automobile Customer Satisfaction Index, the number of faults per 100 cars made in China rose from 246 in 2005 to 338 this year. Four out of five cars now experience a problem in the first six months of ownership. But with average retail prices falling substantially on an annual basis, manufacturers are racing to reduce costs, not increase quality.

Intense competition is also forcing them to accelerate development cycles. Manufacturers acknowledge that this means they are being forced to use lower-quality materials and spend less time on testing. So reliability is likely to deteriorate further. These problems have already delayed Chinese automobile manufacturers' plans to increase export sales in the developed world. Instead, the Chinese cars exported today mostly go to Africa, South-East Asia and the Middle East, where expectations are lower and price matters more.

From an international perspective, local automobile manufacturers in Japan and South Korea gradually came to dominate their domestic markets through a combination of cost competitiveness, nationalistic buying and technological leadership. Today, Japan's Toyota and South Korea's Hyundai make some of the most advanced, reliable, high-quality cars in the world. The accelerated pace of automobile production in Shanghai may be undermining the market dominance of Chinese automobile manufacturers. They have progressed rapidly largely because of government support and cost-conscious and relatively undemanding buyers. But as consumer expectations rise regarding quality, reliability and resale value of vehicles, loyalties are likely to change, changing with them the production values of Chinese manufacturers (*The Economist*, 23 November 2006).

The success of regional innovation clusters in China is the product of the interaction of three factors. First, the central government has played a key role in the formation of the regional clusters by providing the resources and an "enabling framework" for support of the various types of zones, industrial parks, science parks and incubators where national science and technology programmes have often been the drivers. Second, FDI and the growing industrial and technological integration of China with neighboring countries have provided a strong support base to regional development through technology transfer, management skills and extensive links to global markets. Third, the strategic targeting and development of technological and industrial clusters and subsequent reconfiguration of state involvement toward a "steering" role has provided the basis for further development.

To this day much of this drive for industrialisation has depended on FDI. The long-term goal of the central government is to reduce this dependence and make the country more self-reliant in developing its own technological base through advanced research capabilities. This goal rests on a desire to increase independence through economic dynamism. As a result of the success of the industrial zones, regional technology and industrial clusters now play a significant role and their embedded innovation systems might greatly contribute to China's technological and economic development.

This emphasis on regional clusters as key drivers of technological and industrial development is reflected in the sheer economic growth of the selected regions. Statistics from the Ministry of Science and Technology (MOST) show that from 1991 to 2002, major economic indicators of the 53 high-tech development zones in the country grew by almost 50% on an

annual basis, with an increase of total turnover volume from RMB 8.7 billion (USD 1.06 billion) to RMB 1 533 billion (USD 186.9 billion) in 2002. During the same period, the number of workers employed in high-tech regional clusters increased from 140 000 in 1991 to 3.49 million – an increase of nearly 25-fold. At the same time industrial clusters that were originally driven by FDI have progressively involved local companies which through interconnections with FDI have prepared the ground for technology transfer and management skills.

However, cluster policy confronts several challenges which are related to the lack of synchronisation between economic and administrative reform. One such challenge concerns the free movement of labour across regions and across urban and village enterprises. Urban enterprises have provided industrial employment to surplus rural labour, which has also contributed to increasing incomes in rural areas. However, this pattern of industrialisation has several weaknesses. One is the size of the operations of firms in many industries which does not allow for economies of scale. Another is the absence of linkages to services for business development and improvement of the efficiency of rural enterprises.

An equally serious challenge concerns the "holding" nature of many SOEs. Such enterprises often still provide infrastructure facilities and business services that could more efficiently be provided by separate dedicated entities. This issue has partly been addressed through combining SOEs into a number of large group companies, while allocating many of their peripheral activities to the private sector. Nonetheless, despite ongoing restructuring efforts, corporate governance reform with emphasis on private enterprise aligned to market demand is a major policy issue.

General conclusion

The Shanghai region and its automotive cluster yield a number of lessons regarding regional economic policy and cluster support. These can be summarised as follows:

- Current literature on cluster formation and cluster policy stresses that clusters cannot be created *ex nihilo*. Though this is largely true, the case of the Shanghai automotive cluster strongly suggests that, in the era of globalisation, carefully targeted government intervention can create conditions favorable to the emergence of clusters by establishing a structure of incentives toward market and industrial concentration on conditions advantageous to regional economic development.
- Another important aspect of the Shanghai automotive case concerns the alignment of strategic objectives between the central and regional government which has been critical in attracting FDI to the region but also organising the critical mass of local suppliers and their integration into the production process.
- However, the case also highlights certain key lessons central to regional economic policy, especially in transition economies. Primary among them is the need for tight alignment between concepts of technological development and economic contribution. As the two are not the same, economic policy needs to focus on the conditions under which technological development can be converted into economic performance.
- A related issue has to do with the prioritisation of R&D objectives. The Shanghai case highlights the need for flexibility in the planning process that structures research. In particular, the case of funding of research conducted at university and research institute levels which relies heavily on state financing means that research targets might not always

be aligned with market needs, while SMEs in search of financing for innovative projects find themselves in complex and time-consuming procedures of ensuring financial support.

- In sum, the Shanghai case illustrates the need for synchronisation of economic and political reforms around leading market transformations in ways that enable innovative firms take full advantage of emerging market opportunities and contribute to the regions in which they operate.

Based on the foregoing analysis, the following tentative suggestions for policy may be advanced:

- Though government intervention cannot be considered as the "creator" of clusters, it can play a major role in the formation of the conditions favourable to their emergence, especially in the early stages of cluster development. This intervention can be particularly effective when based on the close alignment between national and regional government authorities.
- Cluster policy must clearly distinguish between technological development and economic development. Effective cluster policy depends on "intelligence" mechanisms that can convert technological advances or technology transfer into economic performance within the economic base of a region.
- Funding of research programmes, usually an important axis of cluster development, needs to be assessed according to market demand. Though "ahead of the market" funding usually associated with state sources of finance is important in terms of planning, funding for research must be based on a balanced distribution of funds between universities and SMEs.
- Regional cluster policy must be based on the synchronisation of economic and political reforms around leading market transformations in ways that enable innovative firms to take advantage of emerging market opportunities and contribute to the regions in which they operate.

Notes

1. The report draws on the study "Global Outlook for the Automotive Sector – Future Drivers, Trends and Barriers", prepared for OECD International Future Programme by Dr Peter Wells and Dr Paul Nieuwenhuis, BRASS (Centre for Business Relationships, Accountability, Sustainability and Society Cardiff University), background material provided by the case study regions and interviews with representatives from industry, academia and local and regional authorities. As preparation for the interviews, a questionnaire, focused on basic information and statistics, was completed by the region. The interviews were carried out by the sector expert in collaboration with representatives of the OECD/Nutek Project Team. Sector expert was Dr Takis Damaskopoulos, European Institute of Interdisciplinary Research (EIIR).

   The views expressed are those of the authors and not necessarily an official position of either Nutek or the OECD.

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PART II

Chapter 6

Regional Case Studies in the Biopharmaceuticals Sector[1]

This chapter looks at the evolution of the biopharmaceuticals industry and the impacts that changes in the structure of the industry are having on four regions specialised in drug production and/or biotechnology. In each case, the regions are struggling with the impact of restructuring of the global pharmaceuticals industry but also striving to build on the R&D strengths and innovative capacities that the regions have acquired over time as leaders in a dynamic technology-driven industry.

Global outlook

The pharmaceutical industry has enjoyed steady, and sometimes spectacular, growth since its modern form emerged in the early 20th century and is still one of the most profitable sectors of the world economy. Pharmaceuticals is one of the few branches of manufacturing that has seen growth in both output and employment within the OECD over the past ten years. Total global pharmaceutical sales grew 7% at constant exchange rates in 2005 to USD 602 billion according to the market intelligence company IMS. In the ten major markets, growth was 5.7% in 2005, compared with 7.2% the previous year. This group accounts for 81% of the total global pharmaceutical market, but emerging markets including China, Korea, Mexico, Russia and Turkey all experienced double-digit growth, outpacing global performance. This suggests that in the coming decade, these markets will receive increasing attention both as potential clients, but also, for some of them, as potential sources of competition (see the section on China and India below).

In 2003, total drug expenditure per person was highest in the United States (more than USD 700 per person), followed by France (just over USD 600), Canada and Italy (about USD 500); lowest in Mexico and Turkey (just over USD 100). Significant cross-country variations in spending levels exist also in terms of total health spending. In 2003, the United States spent USD 5 635 per person on health, more than twice the OECD average and around ten times more than Mexico and Turkey. The United States devoted 15% of its GDP to health spending, followed by Switzerland and Germany, at over 11%. At the other end of the scale, Korea and the Slovak Republic allocated a little less than 6% of their GDP to health. The OECD average in 2003 was 8.6%.

The industry is centred on a limited number of very large-selling drugs, so-called blockbuster products. The best-selling drug in 2005 as in 2004 was Pfizer's cholesterol-lowering drug Lipitor, worth over USD 11.36 billion. The number of blockbuster products (annual sales exceeding USD 1 billion) reached 94 in 2005 compared with 36 in 2000 and included 17 products reaching this level for the first time. While six blockbusters are expected to lose their patents in 2006, the launch of new products and continued growth of those already on the market will result in an increasing number of blockbusters over the next five years. Sales of generics in the top eight markets (United States, Canada, France, Germany, Italy, Spain, United Kingdom and Japan) exceeded USD 55 billion, and are expected to experience double-digit growth over the next five years.

Pharmaceuticals have helped to eradicate or render much less deadly an impressive series of diseases. But despite this continuing success, all is not well. Margins are being squeezed as major clients in both public and private health systems demand price reductions. The patents on many big money-earners are expiring, and the pipeline of new products is not being replenished as it once was. Public attitudes are increasingly negative, following well-publicised product withdrawals, price-fixing scandals and even accusations of "disease mongering", *i.e.*, the accusation that pharmaceutical companies exaggerate the

importance of certain conditions just to sell treatments (see, for example, the April 2006 issue of *PloS Medicine*: *http://collections.plos.org/diseasemongering-2006.php*).

The industry is reacting to these challenges in a number of ways, notably by rethinking business models and the innovation process.[2] Biotechnology is a key factor in this shift, both in itself and as part of the convergence with other innovative domains such as nanotechnology and informatics. However, its situation is paradoxical. Although biotechnology will gradually come to dominate the drug development process in the coming decades, the oft-predicted flood of new cures has not materialised, and many biotechnology firms are surviving only because they have sold important assets to bigger companies, while others will either disappear completely or lose their identity in mergers and acquisitions.

Innovation is at the heart of the pharmaceutical industry, and depends on carrying research through to profitable products. However, in recent years, the return on investment in pharmaceutical R&D has been falling due to a number of factors, including the increasing complexity of the molecules studied and the expense of complying with regulatory approval procedures. Estimates for bringing a new drug to the market range from USD 900 million to almost twice that. Biotechnologies can lower some of these costs and speed up processes, and are also changing relationships within the industry. Small firms can develop drug leads and then outlicense these leads to larger firms with the resources to take the drug through the following stages. The experience of large firms adds sufficient value to offset the costs of operating the alliance.

Many governments are seeking to encourage this process by supporting biotechnology clusters. As for the innovation process in general, no single model works across countries or regions, and the success of clusters varies both within and across countries. But the OECD does identify a number of factors that successful clusters share: a strong science base (universities, laboratories, and private firms), availability of finance (from private *and* public sectors), infrastructure, close physical proximity, networks, and an ability to attract a knowledgeable, skilled workforce.

Key drivers and trends

Consolidation and rationalisation of the pharmaceuticals industry

The structure of the pharmaceutical industry was fairly stable for most of the 20th century, seeing comparatively little of the concentration that characterised other major industrial sectors. However, by the late 1980s, overcapacity and the challenges posed by increasing globalisation put pressure on the industry to evolve towards a less fragmented structure and resulted in three waves of mergers. The first wave, in the late 1980s and early 1990s saw the emergence of Bristol-Myers Squibb and Smith-Kline Beecham. The second wave started in 1994 when American Home Products merged with Ayers and Wyeth, followed a year later by the creation of Glaxo Wellcome, Pharmacia and Upjohn, and Hoechst, while in 1996, Novartis was created from Ciba-Geigy and Sandoz. In 2000, Pfizer merged with Warner Lambert and then acquired Pharmacia in 2002.

According to Genetic Engineering News, the top ten pharmaceutical companies by market capitalisation are Pfizer (USD 193.57 billion), Johnson and Johnson (USD 171.53 billion), GlaxoSmithKline (USD 149.61 billion), Sanofi Aventis (USD 114.53 billion), Novartis (USD 111.37 billion), Merck (USD 76.44 billion), AstraZeneca (USD 73.36 billion), Abbott (USD 67.70 billion), Wyeth (USD 67.17 billion), and Eli Lilly

(USD 63.53 billion) (*Pharmalive.com*, 2006). Amgen heads the list of biotechnology firms (USD 93.09 billion) followed by Genentech (USD 89.53 billion), Gilead Sciences (USD 27.96 billion), Genzyme (USD 17.74 billion), and Biogen Idec (USD 15.94 billion). Amgen's market cap increased 28.4% from the previous year and Genentech's grew by 17%. It is worth noting that Amgen and Genentech have market capitalisations greater than five of the top ten traditional pharmaceutical companies. Despite the size of these companies, only Pfizer has a market share of over 10%, so pharmaceuticals still have some way to go to attain the levels of concentration seen in automobiles or computers, for instance.

One of the most significant deals in recent times was the February 2006 acquisition of Germany's fourth-largest generics manufacturer Betapharm by the Indian company Dr Reddy's. The sums quoted (EUR 480 million) are not huge compared with many deals in the pharmaceutical industry, but the other main bidder was also an Indian company, Ranbaxy, suggesting that in the generics market at least, new players are starting to challenge incumbents. The Indian and Chinese pharmaceutical industries are discussed in more detail below.

The number of large pharmaceutical firm-biotech alliances increased from 69 in 1993 to 502 in 2004, but the number of biotech-biotech alliances surpassed the number of pharmaceutical-biotechnology alliances according to figures released by Deloitte Touche, while for the top ten deals, most of the acquirers were other biotech companies (Deloitte, 2005). The type of technology involved in the alliances seems to be shifting away from genomics towards proteomics and bioinformatics.

The rationale behind all the alliances with and among biotech companies is clear. Biotech increases the range of drugs being developed and helps to make the development process itself more efficient. For large pharmaceutical companies, alliances with smaller biotech firms provide access to new products and specialist technologies (Arora, Fosfuri and Gambardella, 2001). Alliances among biotech firms enable specialist companies to achieve the synergies needed to develop new products and services; *i.e.*, to transfer technology or other resources across the value chain. This integration can also be geographic, helping to form clusters in innovation systems at local or national level. However, for some countries, participation in the international innovation system is more important than the national level, as shown by the number of alliances with US firms compared to national ones.

The impact that these alliances with and among biotech firms will have on future industry structure is not clear yet. At one extreme, the biotechnology firms could simply remain suppliers of specialist technologies, with the alliances providing the mechanism for technology transfer. At the other, alliances would only be a temporary phase, providing the funding and other resources the biotechnology firms need to become fully integrated pharmaceutical companies. Given the increasing share of drugs developed using biotechnologies in markets everywhere, it makes sense for biotech companies to strive towards the integrated company model. Counterbalancing this, many biotech companies lack the resources to develop an idea through the long, complicated and expensive process of getting a molecule to the market, so they may have to sacrifice autonomy to ensure longevity.

Biotechnology and the pharmaceuticals industry

The pharmaceutical industry is driven by innovation, and innovation depends on scientific research. In the years to come, this research will increasingly be based on the

biosciences, so the following sections outline some of the main fields expected to contribute the basic knowledge that may be transformed into new therapies at the outlet of the pipeline. (More details can be found in the annexes.) The anticipated benefits of biotechnology for the pharmaceutical industry can be summarised as follows (*Pharmacogenomics*, 2004).

- More powerful medicines. Pharmaceutical companies will be able to create drugs based on the proteins, enzymes, and RNA molecules associated with genes and diseases. This will facilitate drug discovery and allow drug makers to produce a therapy more targeted to specific diseases. This accuracy will maximise therapeutic effects and decrease damage to healthy cells.
- Better, safer drugs, the first time. Instead of the standard trial-and-error method of matching patients with the right drugs, doctors will be able to analyse a patient's genetic profile and prescribe the best available drug therapy from the beginning. This will take the guesswork out of finding the right drug and speed recovery time and increase safety as the likelihood of adverse reactions is eliminated.
- More accurate methods of determining appropriate drug dosages. Methods of basing dosages on weight and age will be replaced with dosages based on genetics, how well the body processes the medicine and the time it takes to metabolise it. This will maximise the therapy's value and decrease the likelihood of overdose.
- Advanced screening for disease. Knowing their genetic code will allow people to make adequate lifestyle and environmental changes at an early age to avoid or lessen the severity of a genetic disease. Likewise, advance knowledge of particular disease susceptibility will allow careful monitoring, and treatments can be introduced at the most appropriate stage.
- Better vaccines. Vaccines made of genetic material promise all the benefits of existing vaccines without all the risks; *i.e.*, activate the immune system but unable to cause infections. They will be inexpensive, stable, easy to store, and capable of being engineered to carry several strains of a pathogen at once.
- Improvements in the drug discovery and approval process. Pharmaceutical companies will be able to discover potential therapies more easily using genome targets. Previously failed drug candidates may be revived as they are matched with the niche population they serve. The drug approval process should be facilitated as trials are targeted for specific genetic population groups, providing greater degrees of success. The cost and risk of clinical trials will be reduced by targeting only those persons capable of responding to a drug.
- Decrease in the overall cost of healthcare. Decreases in the number of adverse drug reactions, the number of failed drug trials, the time it takes to get a drug approved, the length of time patients are on medication, the number of medications patients must take to find an effective therapy, the effects of a disease on the body (through early detection), and an increase in the range of possible drug targets could help cut the cost of healthcare. However, a certain number of barriers to progress will have to be overcome.

Biotech in the value chain: the links with large pharmaceutical firms

The pharmaceutical value chain comprises four large sections: basic research and candidate identification, clinical trials, regulatory approval, and manufacturing and commercialisation. Given the time scale, expense, and complexity of the entire chain, only

the large companies are involved at all stages. They are particularly strong in the last stages (Phase 3 trials, regulatory compliance, sales and marketing). Smaller companies, including almost all biotechnology firms, tend to focus on the early stages such as pure research or early phase trials.

Emerging trends in the collaboration between large pharmaceutical firms and smaller firms will reinforce this division of labour. The mid-2000s have witnessed an increase in deals targeting early stage compounds by large pharmaceutical firms seeking to fill pipelines, but conscious of the fact that the possibilities of acquiring late-stage products via collaboration and licensing deals is limited. The shift towards earlier-stage deals is reinforced by a reluctance to bear as much of the risk for later-stage deals as previously. A comparison of two deals, one from December 2005 and one from 2002 illustrates how things are changing (Anderegg, *et al.*, 2006). In the 2002 deal involving an insomnia compound, Pfizer paid Neurocrine USD 100 million upfront with an agreement to pay up to USD 300 million more in milestones[3] and royalties of 26% to 30%. Pfizer was also committed to funding any remaining development costs and was responsible for the remaining risk. In the 2005 deal involving an atherosclerosis compound, AstraZeneca paid only USD 50 million upfront, with USD 300 million in development milestones, USD 650 million in sales milestones and royalties of 15% to 35%. AtheroGenics has to fund the Phase 3 trials.

Although the division of labour mentioned above will continue, the coming decade is likely to see a drastic reduction in the number of "traditional" deals where large pharmaceutical firms buy and commercialises promising products in return for royalties and various other payments, while accepting most of the risk. The most likely development is that deals involving cost-sharing at all stages of the value chain become widespread, with profit-sharing based on the relative contributions of each partner. This could even extend to co-promotion; *i.e.*, the right to market the final product in a given country or territory. For smaller biotechnology firms, cost-sharing arrangements hold out the promise of much larger income than present licensing deals if the product is successful, and a chance to move up the value chain towards new activities. But it also implies much greater, and more speculative, investment in the early stages of product development; *i.e.*, at a time when a small company may not have the resources to maintain its part of the bargain. The risk is that the small biotech may have to sell valuable intellectual property or some other vital resource just to keep going.

There may be an argument for biotechnology firms to seek partners other than pharmaceutical companies, notably medical device companies. The idea would be to create synergies between the company producing a treatment and another one that develops an appropriate delivery technique. The practical benefits of such an approach seem clear, but investors are likely to remain wary of an alliance that seems to combine the worst of both worlds from their point of view: the long, uncertain development process of biopharmaceuticals plus the smaller returns associated with investments in medtech. For investors prepared to take risks, biotechnology firms specializing in discovery are likely to become more attractive in the coming years, especially given the increasing interest of large pharmaceutical firms in early stage compounds and discovery platforms.

The different segments in this industry can be viewed as independent sectors that share certain common features in that they are all linked to the healthcare sector to varying degrees. They can also be considered as a system in which values are created and

where new fields arise at the point of intersection. For example, there are links with agriculture, pulp and paper, and IT, which are perhaps best captured under the concept of bioeconomy.

Key challenges

Regulation

Pharmaceuticals is probably the most heavily-regulated industry in the world. Every stage of developing, manufacturing and marketing a drug has to obey strict rules; the doctors who prescribe the drug have to possess professional qualifications that take longer to obtain than any other; the pharmacist who supplies the product is subject to strict oversight; and even the patient who takes it has to obey certain rules to be reimbursed. Regulation has three main objectives: ensuring the safety of drugs, preserving the incentives for research and development and the flow of innovative drugs (mainly through protection of intellectual property rights – IPR), and controlling the quantity and quality of drug expenditures.

Safety and IPR regulations are unlikely to change significantly over the period considered here, but in the longer term, regulations for product approval will evolve. The one-off endorsement common at present may give a way to a continuous process where scientific advice is sought for successive stages of the authorisation process. If this approach proves successful, licensing authorities may implement the so-called "rolling dossier", whereby data are submitted on an ongoing basis during development, with the authority reserving the right to see all the data before issuing an approval. In a further stage, the current system of clinical trials may be replaced, or significantly modified, due to the impact of biotechnology-based development and drugs. For example, biotech may allow a number of safety questions to be answered sooner, or the extremely small target population may mean that practically every potential patient would have to take part in the trial to reach the numbers demanded in present-day protocols. In such cases, authorities may demand extensive post-approval testing.

In the short and medium term, price regulation by governments will influence the evolution of the pharmaceutical industry. The future of biotechnology-based pharmaceuticals will be affected by this too, of course, the more so since biotechnology is expected to change not only the type of treatment available, but also the role of health services in preventing disease rather than curing it.

Price regulation

When discussing price regulation, it is common to distinguish the market for non-reimbursed or over-the-counter medicines, for which the consumer pays the full price, the market for reimbursed, prescription, or "ethical" medicines, for which the demand is affected by health insurance and the market for pharmaceuticals purchased by hospitals. Mechanisms used to ensure cost-effective drug consumption include the use of co-payments, formularies, and controls on the prices paid for drugs, on prescribing physicians and on pharmacists (OECD, 2001).

1. Co-payments and reimbursement policies. The incentives for individuals to control their expenditure on drugs depend on the "co-payment"; *i.e.*, the percentage of the cost they pay themselves. This can depend on the drug, the individual (*e.g.*, the poor or chronically ill may pay less) or the level of the annual expenditure of that individual on

drugs or on healthcare (*i.e.*, the individual pays everything up to a certain threshold). When pharmaceutical purchases are covered by health insurance, the consumer is partially or fully insulated from the cost and therefore has a weakened incentive to trade-off cost and quality, to substitute other treatments or to forego treatment entirely.

2. Formularies. Nearly all health insurers maintain a list of drugs they will reimburse, the extent and conditions of that coverage, and any conditions on use or prescribing. This list is known as a formulary. Simple techniques, such as excluding from the formulary drugs that do not meet a cost-effectiveness threshold, can have a big impact on pharmaceutical consumption.
3. Price controls. Most health insurers also control the prices that they pay for drugs (or limit the price which will be reimbursed for a drug). These prices are set in different ways. Where the products in a therapeutic class are close substitutes, the prices of the drugs in that class are often set equal to the lowest price in that class. Where a drug has few close substitutes price-setting is more difficult. It is common to set prices based on international price comparisons of equivalent drugs. If almost all countries set prices on the basis of international comparisons, the importance of the price-setting policies in those countries which do not use international comparisons is magnified. A few countries fix prices on the basis of costs (also known as profit controls). These policies are also occasionally complemented with other industry-wide controls such as a limit on annual rate of increase, a broad freeze on prices or an enforced across-the-board price reduction. From a theoretical perspective, pharmaceutical prices should be set on the basis of cost-benefit analysis, also known as pharmaco-economic analysis. This analysis quantifies the beneficial effects of a drug (*e.g.*, fewer side-effects, fewer hospitalisations) and compares it with the cost. In principle, all those drugs (and other health inputs) with a benefit-to-price ratio above a given threshold should be accepted. Several countries have adopted a policy of using pharmaco-economic analysis to assess the quality of pharmaceutical and other healthcare spending. However, the price of a drug can vary considerably, even among OECD countries, leading to "parallel trade", where the drug is imported from a cheaper destination, rather than being bought in the country of use. This is discussed more fully below.
4. Controls on physicians and pharmacists. Most insurers control the prescribing practices of individual physicians, to ensure the most cost-effective treatment of patients. These controls typically take the form of prescribing guidelines or controls on who may prescribe certain medications. Some countries also impose nominal or explicit "budgets" on prescribing physicians or give a financial incentive to doctors who achieve a certain level of generic prescribing. In a few cases, the payment to the health care provider is fixed, giving strong incentives to economise on pharmaceutical use along with all other health inputs. The clearest example of this is the United Kingdom "GP Fundholder" programme under which the local doctor is given responsibility for purchasing healthcare services on behalf of a group of patients in return for a fixed per capita payment. Such schemes rely on competition between doctors to ensure incentives to maintain quality are retained. Many insurers also control the activities of pharmacists. Since pharmacists are typically compensated on the basis of a percentage margin on the products they sell, in the absence of explicit controls they have an incentive to increase rather than reduce the price of the medications they sell. Many countries allow, encourage or require substitution of cheaper bio-equivalent products. In some cases, pharmacists are allowed to keep some of the cost-savings from substituting cheaper

equivalent products. The costs of maintaining a retail distribution network are a substantial component of the total costs of pharmaceuticals. Where consumers are insured against the price of pharmaceuticals they have no incentive to shop for the cheapest pharmacy and competition between pharmacies cannot be relied upon to ensure efficient and effective delivery of pharmacy services. In these cases, it is necessary to regulate the margins of pharmacies.

Biogenerics

The patents on many leading therapeutic proteins (biologics) such as human growth hormone will expire over 2005-2010, theoretically opening up at least half of this USD 30 billion-a-year market to competition from biogenerics. Not all biologics would be replaced, but if experience with traditional compounds is repeated, biogenerics could take up to 15% of the market. (The nightmare scenario for patent-owning manufacturers would be a repeat of Prozac, where Eli Lilly lost almost 90% of its sales to a generic.)

The size of the market alone would seem to make it potentially attractive, the more so given the high cost of the patented products plus the fact that in the major market, the United States, recent changes in drug prescription rules for Medicare could lead to soaring demand for biologics, followed by political pressure to reduce the concomitant budgetary consequences. As of 1 January 2006, everyone with Medicare, regardless of income, health status, or prescription drug usage, will have access to prescription drug coverage, at an estimated cost to the federal government of around USD 700 billion over 2006-2015 (*Medical News Today*, 2006; see also *www.medicare.gov/medicarereform/drugbenefit.asp*).

A number of programmes to develop biogenerics have been reported over the past five years as the patent expiry date approaches. These often involve partnerships of North American and European companies with partners from other parts of the world (Polastro, 2001). The scientific and technical challenges are considerable, but the main obstacle may turn out to be regulatory. The European Medicines Agency EMEA published draft guidelines for four biogeneric products in the first quarter of 2006, with guidelines on quality and other issues to follow (EMEA, 2005), but in the United States, the FDA has made little progress in establishing an approval pathway. This may change over time due to financial pressures arising from the Medicare reform mentioned previously, but in the shorter term, the FDA may be forced to act as a result of a lawsuit brought by Sandoz regarding Omnitrope, a generic form of human growth hormone. Sandoz filed its application to the FDA in 2003, but the Agency said that although it could not identify any deficiencies in the application, it was unable to reach a decision because of scientific and legal uncertainties. Sandoz meanwhile launched Omnitrope in Australia (priced 25% below the non-generic form) and in January 2006 received a positive response from the EMEA (see *www.sandoz.com/site/en/company/media/news/detail/Omnitrope_20060127.shtml*).

Whatever the FDA decides regarding Omnitrope, the approval process for biogenerics will require much more data than traditional chemical generics because proving biosimilarity is more difficult and regulatory guidelines will have to be defined product by product, probably meaning also that abbreviated procedures similar to those used for conventional generics in the United States will not be developed (Ansell, 2006). Regulatory barriers will not be the only delay: companies marketing branded products will probably use legal means such as patent lawsuits to defend themselves from generics. These constraints lead some industry analysts to forecast that although biogenerics will start to

claim market share in the latter-half of the decade, they will not become fully established before the 2010s (*Datamonitor*, 2005).

The question also arises of who will actually produce the biogenerics. Generics manufacturers generally prefer low-risk strategies supplying dependable if unspectacular returns, and may in some cases even try to develop branded biologics given that the resources required are similar to those for a generic, but with better profit margins. Start-ups are unlikely to have the financial and other means to go far in this sector. Given the cost and complexity of developing and marketing biogenerics, established companies may prefer to concentrate on branded products, especially where the generics threat is distant. Where the threat is immediate, they are best-placed to take advantage of the new opportunities created. In the foreseeable future, therefore, generics are unlikely to threaten the profits of the major pharmaceutical companies, although they may have an impact on a certain number of products.

Cosmeceuticals and nutraceuticals

The pharmaceutical industry may suffer from a poor public image, but this has not prevented the expansion of the market for pharmaceutical products into non-medical applications, although it is probably more accurate to speak of products with implied pharmaceutical properties. Foremost among these are "cosmeceuticals", which, as their name implies, are cosmetics containing pharmaceutical-style components. Cosmeceuticals are applied like cosmetics, but claim to contain ingredients that act on the skin's biological functions. The US market alone was worth an estimated USD 12.4 billion in 2004, up 22% from 2000, and is projected to reach at least USD 16 billion by 2010 thanks to ageing baby boomers (Barrett, 2005).

Given this demographic influence, the most widely-used cosmeceuticals are "anti-ageing" products, notably retinoids, vitamin A (retinol) derivatives present in all living organisms, and hydroxy acids. Some studies claim that retinoids can partially reverse sun damage to skin, but the results quoted are generally from in vitro tests that can be criticised for being poorly constructed, so authorities such as the FDA generally find their utility in clinical situations marginal at best. Hydroxy acids are supposed to make the skin appear smoother through actions such as increasing the density of collagen, but once again, the scientific evidence is incomplete and controversial (Schwartz, *et al*., 2006). Some cosmeceuticals such as Botulinum A exotoxin (Botox) or the antimicrobials used in antidandruff shampoos do have demonstrable effects, but the vast majority of these products have so far failed to meet the standards of evidence-based scientific trials.

It is thus not surprising that licensing authorities do not recognise cosmeceuticals (or nutraceuticals) as a category, generally defining pharmaceuticals as non-food products that affect the structure of functions of the body for use in the prevention, diagnosis or treatment of disease, while cosmetics are considered simply as products for cleaning or beautifying the body. Some products correspond to both definitions so must meet the stricter requirements of drug approval, but many others are either in the grey area between the two or clearly have no pharmaceutical effect, although they may be manufactured by drug companies.

Nonetheless, pharmaceutical companies active in this sector can take advantage of existing know-how and resources to propose products and services without the costly risks associated with drug development. This trend is likely to be reinforced by mergers and

partnerships involving pharmaceutical companies and enterprises from other domains that exploit similar or complementary technologies; *e.g.*, plant biochemistry for the development of phytochemicals. Nutraceuticals, sometimes called "functional foods", fall into this category.

Counterfeiting

Most, if not all, types of drugs are susceptible to counterfeiting, and the counterfeiters are putting fakes on the market extremely rapidly. The US authorities have already intercepted so-called "generic Tamiflu" destined for China, following media reports of the outbreak of avian influenza (no such generic exists). The Internet contributes to the problem, the more so since many sites selling cheap drugs give the false impression that they are subject to strict control; but many sites require no prescription before sending drugs, and the customer has no real way of knowing where the drug came from and what it contains. The cases listed below give some idea of how widespread the problem is (Cockburn, *et al.*, 2005).

- One-third to one-half of packets of artesunate anti-malarial tablets bought in South-East Asia were fakes, containing no active ingredient at all.
- Almost 200 000 Chinese patients are reported to have died in 2001 from fake drugs, and in the same year Chinese authorities closed 1 300 factories while investigating 480 000 cases of counterfeit drugs worth USD 57 million.
- In North America, counterfeit atorvastatin, EPO, growth hormone, filgrastim, gemcitabine, and paclitaxel have been reported.
- Counterfeit Reductil, an obesity medication, has been found in Britain.
- The Colombian anti-drugs agency INVIMA confiscated 6 million doses of counterfeit Voltaren anti-inflammatory eye drops, representing more than the country's annual consumption.
- Nigeria threatened to ban the import of all drugs from India, a major supplier, because of the high prevalence of counterfeits amongst the imports.
- In Haiti, Nigeria, Bangladesh, India and Argentina, more than 500 patients, predominantly children, are known to have died from the use of the toxin diethylene glycol in the manufacture of fake paracetamol syrup.
- During the 1995 meningitis epidemic in Niger, the authorities received a donation of 88 000 Pasteur Merieux and SmithKline Beecham vaccines from neighbouring Nigeria. The drugs were found to be counterfeit, with no traces of active product. Some 60 000 people were inoculated with the fake vaccines.
- Counterfeit antiretrovirals used to combat AIDS were discovered in central Africa.

As mentioned in the introduction, it is hard to know the exact scale of the problem. Unofficial estimates quoted by the WHO for the percentage of the total pharmaceutical market represented by counterfeit drugs range from 1% to 50%, while the WHO's own estimate, like that of the FDA, is that 10% of all medicines sold world wide are counterfeit; *i.e.*, annual criminal sales worth over USD 35 billion (Forzely, 2006). This figure was challenged by Harvey Bale, president of the Pharmaceutical Security Institute, at a conference on intellectual property rights organised by the OECD (Bale, 2005). He argued that 85% of the world pharmaceutical market is in the developed world, where counterfeits are less than 0.2% of the market, so the incidence of counterfeiting in the remaining 15% would

have to be 66% to reach the 10% claim. However, the sources for some of the statistics he cites later include "some sampling", "guesstimates", "anecdotal" and "some survey work".

Whatever the actual sums involved, almost all stakeholders agree that the problem is growing, and that the market is being driven by many of the same trends affecting legitimate trade, such as globalisation of the supply chain and new technologies, in addition to specific causes such as weak regulation and enforcement. The damage to public health is direct and immediate if the drugs are ineffective or dangerous, and there are longer-term impacts too; *e.g.*, when diluted compounds facilitate the build-up of resistance. There is also the worry that the public will start to lose confidence in the pharmaceutical industry.

Parallel trade

Differences in national price control policies translate directly into price differences that can be substantial. A study by the US Department of Commerce's International Trade Administration estimates that aggregate pharmaceutical prices in 11 OECD countries are 18 to 67% less than US prices.[4] When extrapolated to a broader set of OECD countries, the loss to pharmaceutical companies on patented medicines is estimated at USD 18 to USD 27 billion annually. Given the share of R&D in company spending, this would mean an extra USD 5 to USD 8 billion a year for product development, on the simple assumption that the "extra" income would be distributed along the same lines as current budgets. The Department of Commerce argues that the additional cost of patented drugs could be offset by higher utilisation of generics, with savings estimated at USD 5 to USD 30 billion annually.[5]

The Internet and cheap communications, particularly mobile communications, have abolished the time and location constraints on many daily activities. Banking, shopping and entertainment, for example, are available to many OECD citizens, and an ever-increasing number elsewhere, when it suits them, rather than the traditional suppliers. Health services are one of the few domains where the client still has to adapt to the supplier, for obvious reasons. However, this too is bound to change, as a result of advances in technology and the spread of an attitude that might be summarised as "when I want it, where I want it, and at the best price possible if I have to pay". Drug sales are already carried out over the Internet, for example many US citizens take advantage of lower prices in Canada to order prescription drugs. Canada's Fraser Institute even claims that trade through Internet pharmacies has grown to such an extent that it is jeopardising Canadians' access to prescription drugs. The Institute quotes estimates that there are 278 cross-border Internet pharmacies in Canada whose annualised value of drug sales to the United States as of June 2005 was USD 507 million at manufacturer prices. This is down 18% from total sales of USD 618 million over the previous 12 months, but the final price charged to American consumers is probably higher than these figures and does not include cross-border sales through "brick-and-mortar" pharmacies (See the following link for a series of articles on the subject: *www.fraserinstitute.ca/pharmaceuticalpolicy/index.asp?snav=pa*).

Differences in policies regarding price controls lead to differences in the wholesale prices of pharmaceuticals across different countries. This, in turn, encourages international trade in pharmaceuticals, known as parallel trade, generally justified by one or more of the following hypotheses:

- Cross-country effect: Parallel trade leads to price equalisation across countries – "arbitrage" leading to more efficient market operation.

- Destination country effect: Increased price competition in destination countries reduces overall pharmaceutical prices, benefiting payers and patients.
- Aggregate welfare effects: If price competition is the result of parallel trade, then the resulting price convergence may lead to overall welfare improvements for payers.
- Patient benefits: Patient access to innovative medicines is improved, with lower direct and indirect costs.
- Industry impact: Parallel trade has minimal impact on the pharmaceutical industry as a whole, in terms of profitability and potential to innovate, and indeed, improves overall industry efficiency.

However, according to a study of parallel trade in the EU by the London School of Economics, no measurable direct benefits accrue to patients due to the structure of user charges, and patient access to medicines is unaffected (Kanavos, *et al.*, 2004). The vast majority of benefits from parallel trade accrue directly to parallel importers, where gross profits and revenues accrue over time in line with higher penetration rates. Taking the same sample of products across all study countries suggests that parallel imports for 2002 sales to the six major destination countries accounted for only 0.3 to 2% of national medicine budgets, representing a total saving of just EUR 44.7 million (or EUR 100 million if estimates for the clawback are included) over locally developed and manufactured products. The parallel importers who bought these same medicines from across the EU made profits of EUR 648 million. In the United Kingdom, for example, the NHS saved EUR 55.9 million (if the clawback is included), or 2.8% of the medicines budget from parallel imports in 2002, *versus* a mark-up of 49% and profits of EUR 469 million made by the parallel importers who sold these products.

Policy makers may be sensitive to arguments for restrictions on parallel trade, particularly in countries with an important research-based pharmaceutical industry. However, the savings to health systems, though small, are immediate and quantifiable, while the benefits of stopping the trade would be longer-term and uncertain.

Where the industry is going: from blockbusters to biotech

Before considering this, it is worth recalling the salient features of the model that dominates at present. The traditional business model for developing and marketing drugs features strong vertical integration from the laboratory to the point of sale in the hope of creating a blockbuster. In pharmaceuticals, only one compound in a thousand even makes it as far as the first stage of clinical trials; it takes over a decade for a new compound to reach the market as a drug; and an estimate based on data from 1983 to 2000 indicates that a typical new drug costs around USD 900 million to bring to market in a country such as the United States (Ki, 2003). Even this colossal sum may be an underestimate, with some analysts calculating a total almost twice as large (USD 1.7 billion) once indirect costs, costs of product launch, etc., are factored in (Gilbert, *et al.*, 2003). This analysis suggests that higher total cost, combined with lower average margins and shorter exclusivity periods, translates into returns on investment of only 5% for an average compound, which is significantly less than the risk-adjusted cost of capital for the industry, and that there is only a one-in-six chance of a new compound achieving a return on investment of 12% or more.

Increased costs and lower return on investment are due partly to the decline in R&D productivity in pharma. Pharmaceutical firms already invest a greater percentage of sales

in R&D than any other industry, but without a new model, costs will continue to rise. The high costs are due to three, interrelated factors (Danzon, *et al*., forthcoming):

1. High input costs for both drug discovery and drug development, including human clinical trials.
2. The various scientific and regulatory steps necessary are extremely time-consuming, taking 12 to 15 years.
3. High failure rates (for each new compound that is approved, roughly five enter human clinical trials and 250 enter preclinical testing).

Biotechnologies can lower some of these costs and speed up processes, and are also changing relationships within the industry. Small firms can develop drug leads and then outlicense these leads to larger firms with the resources to take the drug through the following stages. The experience of large firms adds sufficient value to offset the costs of operating the alliance (Nicholson, *et al*., forthcoming). The probability of success varies substantially across therapeutic categories but firms appear willing to undertake projects with lower probabilities of success in categories where the expected sales, if successful, are relatively large, consistent with a model of dynamic, competitive entry. Products developed in an alliance tend to have a higher probability of success, at least for the more complex Phase 2 and Phase 3 trials, particularly if the licensee is a large firm; *i.e*., there are economies of experience in these stages, but not for the simpler, Phase 1 trials.[6]

The overall cost of manufacturing and supply operations will grow further, owing to the increasing expense of regulatory compliance as well as the growing complexity of the molecules themselves. At the same time, health service providers are increasingly reluctant to pay the high prices demanded to recover investment costs, while patent challenges limit the total revenue potential of the average drug. The market data quoted above show that the blockbuster model is far from finished, with 94 blockbusters in 2005 compared with 36 in 2000 and 4 in 1992. Moreover, biotechnology is contributing blockbusters of its own: 17 according to one study of R&D productivity (CHA Reports, 2006). However, to remain viable in the long term, productivity will have to reverse the downward trend and improve to an extent that appears unlikely at present. Apart from supplying new drugs, biotech could provide a reprieve; *e.g*., improved preclinical toxicology screening could increase success rates and reduce expensive failures in the later stages of development, while automation of clinical trials could reduce time to market and total cost. Sales and marketing costs could probably be reduced too, but even if all the cost-saving measures prove successful, they are unlikely to assure the long-term viability of the blockbuster approach. None of the biotech-based drugs approved by the US FDA in 2005 were blockbusters (van Brunt, 2005).

High-tech high-cost industries such as computer manufacturing show that industries can change their business models successfully, and that the best source of inspiration is often small, relatively new firms. In pharmaceuticals, this essentially means biotech firms, and a number of pointers can be derived from their experience:

- Focus. Research in one area can sometimes produce results elsewhere, leading to unexpected and perhaps even spectacular success, as the case of Viagra shows. However, such windfalls are the exception, and the vast majority of drugs are created by companies with significant experience in the category concerned. Smaller companies have succeeded by focusing in a number of different ways; *e.g*., on specific biotechnologies or diseases. Moreover, generic drugs will increasingly compete with

today's blockbusters, so big companies may find that in the future it is more profitable to develop specialist treatments rather than "one size fits all" primary-care therapies. Marketing costs are also likely to be lower than those in the primaries markets, which require large sales forces and are likely to attract more competitors.

- Partnerships. Large pharmaceutical firms tend to do everything themselves, unlike Hollywood or the IT industry, whose successes are made by recruiting the best available talent, as and when needed, even if this means collaborating with companies who may be rivals elsewhere. For example, a company that makes a promising discovery in an area where it lacks experience could seek a partnership with a company with more experience in this area.
- Complete solutions. Once again, the computer industry provides a good example of how firms can grow by supplying various applications and services to exploit a core product. Although the actual drug itself will remain the biggest source of profit for some time to come, biotech offers the possibility to provide an integrated package of diagnostics and other complementary products and services to make the therapy more effective, so-called "personalised medicine".

Combining these different aspects into a business model that can exploit the potential of biotechnology will require a major reorganisation of company structures away from the traditional function-based approach (R&D, marketing, etc.) towards smaller units capable of moving flexibly to identify and exploit emerging opportunities.

Stockholm, Sweden

Introduction and basic data about the region

Stockholm is the capital of Sweden and located on its eastern coast. The city of Stockholm is part of the much larger Stockholm county. Together with five other counties, Uppsala, Södermanland, Västmanland and Örebro, Stockholm county forms the Mälardalen region, which is of principal importance to Sweden as its major economic engine. The region produced 39% of the GDP in 2002 and its growth is significantly higher than in the country as a whole. However, there are several ways of delimitating the region and for the purpose of this study data refers to the three counties of Uppsala, Stockholm and Södermanland. These data also correspond relatively well with a functional definition of the Stockholm region.

Stockholm county is, from a growth perspective, the strongest region in Sweden. Between 1995 and 2004 the average regional annual growth (GRP) was 5.5%. The accumulated growth for the same period was 63% compared to 44% on the national level. The rate for openly unemployed in the county of Stockholm was 4.2% at the end of 2005, compared to 5.6% for the whole country.

Several of Sweden's largest and most well-known universities, such as Karolinska Institute (KI), Stockholm University, Royal Institute of Technology (KTH), Uppsala University and Swedish University of Agricultural Sciences are situated in the Stockholm-Mälar region.

The region hosts a number of strong "clusters" in several sectors such as ICT, biopharma, financial services and logistics. These are dominated by a few firms, for example, Ericsson, Nokia and IBM in ICT, AstraZeneca, GE Healthcare and Pfizer in biopharma.

Formally, the County Administrative Board is the principal regional governing body representing the national government. Swedish municipalities are autonomous in relation to the national level and have their own elections every fourth year. The County is responsible for regional economic development while local government is providing public services and supporting local economic growth. Another separately-elected administrative body, the County Council, is responsible for healthcare, public transport and regional planning. Due to the allocation of public resources, the city of Stockholm is the most influential governing body in the county.

The biopharma sector in the Stockholm–Mälar region

The Swedish biotech industry is Europe's fourth-largest and the world's ninth-largest as regards the number of enterprises. In relation to the population, the pharmaceutical industry and medical technology industries are also very extensive. Sweden has great potential to continue to be one of the world's leading nations in applications and industries based on life science.

Sweden, and especially the Stockholm region, has a long tradition of internationally competitive life science research with effective collaboration between researchers at the universities, industry, authorities and the healthcare sector. The Swedish pharmaceutical and medical device industry has emerged as a result and has generated a number of globally competitive innovations such as the pacemaker, gastric ulcer drugs, diagnostic allergy tests and equipment for protein separation. Two major pharmaceutical companies have started in the region. One traditional strength in Sweden has been clinical testing. This comparative advantage has diminished over the last 15 years since the Swedish healthcare system has been decentralised.

In 2004, the sector employed approximately 45 000 people nationwide in 1 300 companies with an annual turnover of EUR 19 billion. The Stockholm region is the strongest region with an annual turnover of EUR 12 856 and 30 000 employees. This equals about 2.5% of the total number of employed in the Stockholm region in 2005. The region attracts several of the world's leading life science companies and there has been a significant increase in the number employed in the biotech sector, with an annual growth rate of 10% between 1995 and 2003 (Sweden Bio) and the annual turnover in the Stockholm region increased by approximately 8% between 2001 and 2004. The pharmaceutical industry is an important net exporter and has been the largest growth sector since the mid-1990s. The sector is small in absolute terms when it comes to number of employees but the sector is the fastest-growing as regards salaries and employment. Moreover, the sector is an important net exporter. Also in this context, the sector has, between 1997 and 2003 been one of the fastest-growing (in the region as well as in Sweden). Moreover, it should be noted that biotech is one of the only sectors within prioritised growth areas that has been growing.

The cluster contains all parts of the value chain and could be seen as coherent. To a large extent, the biotech companies in Uppsala focus on biotechnology-based tools for application in the pharmaceuticals industry or within diagnostics. Stockholm provides a strong group of companies across the drug development value chain and in early stage research, while Strängnäs, south of the region, puts more focus on drug manufacturing and production processes. On the other hand, the sector is dependent on a few large companies (AstraZeneca, Pfizer, GE Healthcare) which makes the sector vulnerable to changes in company strategy and localisation. Lack of financial resources and national priorities

concerning resources allocated for research might also be a problem, as well as the fact that the region may be too "research-driven" with too few production facilities. One result of this is that the demand for highly skilled human capital is strong. Companies both compete and co-operate in attracting skilled-personnel.

During the last decade, the life science sector has experienced several mergers and restructuring of major companies resulting in several spin-offs and new employment opportunities. In 1999, Sweden's largest pharma-company Astra merged with British Zeneca and formed AstraZeneca. The head office was moved to London, while the main R&D units remained in Sweden (Södertälje and Gothenburg). The new company expanded its operations in Sweden and the number of employees increased by nearly 40% between 1997 and 2003. Pharmacia went through a number of mergers and reorganisations during the 1990s which has contributed to the current dynamics of the sector. New companies have emerged and the total number of employees has increased by 19%. Pfizer are currently concentrating most of their Swedish operations, including applied research, in Strängnäs and decided in 2005 to further invest SEK 1.8 billion in the Strängnäs plant as it is to be given the status of a centre of excellence. An important decision both for the local economy and the life science sector nationwide since it was regarded as a proof of Sweden's high level of expertise in medicine and biotechnology research. As for the globalisation of R&D, the implications for the region will mean increasing pressure on the industry. AstraZeneca, for example, are outsourcing R&D as well as shutting down some production facilities. Moreover, young companies are bought by international firms and, thus, there is a risk – if the region does not provide the resources needed for developing the industries – that strategic activities would be relocated to other biotech hot beds. Therefore, it is immensely important that companies manage to keep strategic functions (HQs, R&D activities) in the region, since these activities make the firms more attached to the region.

Regional governance and strategies

The general business climate is important for cluster growth and development. These comprehensive conditions are to a great extent decided on the national level, for instance, tax policies and market regulation policies, but also issues such as investment in large infrastructure projects: motorways, railways or airports. Other policy areas on the national level relevant and important to clusters are of course industrial and regional policies.

Even more relevant for cluster development are national policies on education, research and development as well as innovation systems. In general, money is distributed via national programmes[7] and tender procedures in open competition.

The comprehensive regional planning of the facilities for economic development is the responsibility of the County Council and its expertise at the Office of Regional Planning and Urban Transportation. There is no single, unified economic development strategy for the entire Stockholm region. The fact that the region consist of several administrative units reflecting neither the Stockholm labour market area, covering two counties, nor the expanded Stockholm-Mälar region, covering five counties, leaves the governance structure somewhat complicated and fragmented and not well-adapted to the tasks and challenges it faces. The administrative borders do not match the functional borders with respect to, *e.g.*, labour markets and commuting; and the regional level does not have the authority to work with these issues since it lies within the jurisdiction of local municipalities, which have both the resources and capacity to implement strategies.

The County Council put together the Regional Growth Programmes (RTP) and the Regional Development Programmes (RUP) which aim broadly to sustain regional growth and better co-ordinate efforts of local actors, through collaboration for the development of overall strategic plans. However, these plans and programmes could not be described as comprehensive economic development strategies, since the resources and ability to implement the strategies rest with municipalities. Furthermore, the programmes are regarded as platforms for common understanding with no direct financial means allocated.

In terms of cluster policy, there are two national cluster programmes implemented at present, VINNVÄXT and Nutek's Regional Cluster Programme. Also to be mentioned is Visanu, which ended in December 2005. Visanu was a joint-initiative in which VINNOVA (the Swedish Governmental Agency for Innovation Systems), Nutek (Swedish Agency for Economic and Regional Growth) and ISA (Invest in Sweden Agency) supported a three-year cluster programme. As concerns regional strategies to support the life science sector, it is important to note that the sector is one of five prioritised growth areas by the national government and one of the key areas in all three RTP documents relevant to the Stockholm region. In the context of regional strategies, it is interesting to consider that a number of initiatives have been launched in the region. Several of these initiatives have been supported by national actors such (VINNVÄXT, Visanu and Nutek's regional cluster programme).

During the last six or seven years, a number of industrial cluster initiatives have emerged in the region, supported by the public sector. In their initial stages, many of these initiatives were often linked to the general regional development process (and in this context often supported by one or another national funding structure). Stockholm Bio Region aimed to co-ordinate the different initiatives in the life science sector in the region. STAND UP was a strategic group consisting of the three county council governors, CEOs, participants from academia and from the cluster initiatives formed in 2002. The aim was to support a more well-functioning system for regional governance. However, since the autumn of 2006, Stockholm Bio Region as well as the STAND UP group have been terminated and other actors are taking over their mission.

The main actors in this context are some of the cluster initiatives. Uppsala Bio is a collaboration between the local biotech industry, the two universities in Uppsala, and the regional development bodies. The initiative aims to contribute to long-term growth of the biotech sector in the Uppsala region. The initiative is one of five original pilot projects initiated in 2001 to fully develop a model for the coming VINNVÄXT programme. The Biotechvalley cluster initiative has the ambition of strengthening the biotech industry in the entire region and was important in the process of co-ordinating and facilitating Pfizer's site-selection, for example, by acting as an intermediary between the local and national policy level and in marketing the advantages of Strängnäs and Sweden (providing information, finding the right contacts, etc.). Biotechvalley also works as a virtual pharma company and can play a vital role as a help to SMEs in assisting them so that when a large company wants to buy a small company they can be assured that the company has gone through certain procedures and followed regulatory guidelines. Biotechvalley is supported by the Nutek's regional cluster programme. Uppsala Bio, on the other hand, has a more "local" perspective and focuses mainly on Uppsala. On a vertical level it can be said that these cluster initiatives, through their triple helix approach, actively work to bring actors

from different levels of the governance structure (local, regional and national) and from different sectors (public, private and university) together.

Biotechvalley, Uppsala Bio, Uppsala Innovation, Karolinska Holding and Stockholm Business Arena are, thus, actors/initiatives that little by little have emerged as embedded in the industry, mainly by providing different types of added values. Moreover, these actors are increasingly starting to co-operate. One such case in point is the co-operation between Biotechvalley and Karolinska Holding concerning support for young start-ups, etc. Stockholm Business Arena, Uppsala Bio and Biotechvalley (together with the municipalities in the region) are co-operating concerning branding and marketing of the region. Uppsala Bio and Biotechvalley have gradually started to work to upgrade competence in the region. Stockholm Bio Region and STAND UP are now defunct. The most prominent feature in this process is the strong bottom-up perspective.

What, then, are the roles of clusters and cluster policies in the region? The life science cluster initiatives presented in this report can be seen as working to link actors both on a vertical and a horizontal level. Horizontal by trying to bridge traditional geographical and administrative barriers between the counties and municipalities. Vertical by bringing actors from academia, industry and the public together in order to facilitate a more effective innovation and commercialisation process in the region. This is, to some extent, the main goal for regional policy makers in meeting the challenges of globalisation. Much of the work within clusters and in regional growth programmes also aims to secure a supply of qualified labour for local industry. One of the main future challenges is the lack of skilled workers, so the universities need to co-operate to develop the skills needed, not only with a focus on product development but technology development. The relationship between large firms and SMEs is quite weak and further collaboration mechanisms are needed in order to integrate SMEs with research institutions, the private sector and government. Cluster policies are also important in this context.

General conclusion

There is a strong common understanding concerning the importance of the sector for the regional economy. Different tendencies are emerging, with various actors trying to bridge traditional geographical and administrative barriers between the counties and municipalities; *e.g.*, the Stockholm Business Region initiative. It is also important to note that there is some flexibility at the local level. When Pfizer chose to invest in the Mälardalen region, factors influencing this decision included a critical mass of production competence and the fact that the local municipality was very flexible as regards infrastructure planning. In terms of cluster policy, the national cluster VINNVÄXT, Visanu and Nutek's regional cluster programme initiatives have benefited the life science clusters. Cluster initiatives in the region can be seen as working to link actors both on a vertical and a horizontal level. The success of Biotechvalley and Uppsala Bio is built upon the energy of such firms, with the support of the universities.

The different life science initiatives are embedded in an environment which in itself is strong and tradition-bound: old universities, international connections and ownership in the corporate sector and the other components of the triple helix, etc. Various points of inertia are built into this system, regardless of the existence of the cluster initiatives. The fragmented governance structure, divided into several administrative and political regions, is considered to obstruct co-ordination between the life science clusters in the region. No public actor has taken the role of "intraregional leader" but the cluster organisations are

important in this context. An overall-functioning triple helix constellation in the proper sense of the term does not yet exist in the region, for reasons related to both institutional and organisational aspects. Compared with other regional initiatives in Sweden, the Stockholm region would certainly seem fragmented and complex. At the same time, it could be questioned whether it is even possible to compare a region like the Stockholm region with other regional environments in Sweden, even though several of the environments described definitely have potential with respect to competitiveness and resources (firms, research, branding, etc.).

The region is also characterised by the existence of many different players which in themselves are strong enough to pursue their own agendas, but perhaps are not strong enough to fill any structural holes in the network. It is extremely difficult to navigate in the public support system with 30 different but overlapping organisations. Perhaps this is why the network structure and consequently the impediments to collaboration look different in such a region, in an urban innovation system of this type. Initiating interplay in Stockholm may require other types of initiatives and arenas. One such initiative may be to free up resources for players that can go between the different policy layers. In brief, what may at first appear to be fragmented and not interconnected may not necessarily be so; it might more accurately be described, simply, as a "big city problem".

Perhaps it is merely that the process exemplifies the problems and opportunities of doing "business as usual" in a big city reality. To some extent, we find this in the other regions as well. There are also differences as regards prioritisation in the regional growth programmes. Moreover, it should be noted that the public sector is the driver in many development, cluster and innovation system strategies. One of the major implications in this context is perhaps that policy measures have a tendency to be more supply-driven (focusing on research) rather than demand-driven (focusing on the market).

In terms of more sector-specific problems and challenges, which are not necessarily a result of the regional governance structure, is the fact that Sweden lacks appropriate and relevant tax incentives targeted at R&D-intensive companies. The lack of these incentives is probably an important factor working against the biopharma sector in Sweden. Secondly, there is a lack of capital in the region. Thirdly, the number of young R&D companies may be a problem since it is not self-evident that funds and financing will be available after companies have left their pre-seed phase. Last, but not least, it must be stressed that, albeit a national policy and high visibility in regional strategy documents, a more long-term vision concerning the role of biotech is lacking, support-wise and financially as well as regarding its role in the regional economy.

A number of new firms have emerged in the region. Some actors have argued that the region may even contain too many in relation to its size. Moreover, another challenge is the fact that the large pharmaceutical companies are downsizing in the region. AstraZeneca has been crucial for the growth of the sector.

Taking the above conclusions into consideration, what advice is appropriate? One of the more important policy implications in the Swedish context is that Swedish policy makers from the national to the regional level need to be more proactive. A strategy for life science now exists, but the sector is in need of more resources. Tax incentives might also be considered. This is by no means the only solution and/or a quick fix, but almost every other competitor nation-wise offers such measures, in one way or another.

Another challenge is, understood broadly, the financing aspect of biopharma (regardless whether it's public or private money). This has implications for young, R&D-driven DBFs in early stages as well as for AstraZeneca (health and social policies, reimbursements, providing a milieu for clinical trials, providing innovative financing, etc.) Regional funding could also improve different co-operative measures. Problems related to co-operation often exist within the public sector, while business and academia function somewhat better. Sweden should consider focusing on measures to support the industry, competence-wise. The educational system needs to be more closely-matched with firm needs in order to ensure future supply of qualified labour.

Despite high international ranking in research and education, low mobility between the sectors and few incentives for co-operation characterise the relationship between the educational establishments and trade and industry, as well as the fact that academic research is not valued in business and business experience is not a merit within academia. Instead of spreading the funds to several regional colleges, it is importance to allocate the means to the strong universities in the Stockholm region in order to maintain a critical mass and close connection to the international companies in the region. Moreover, there is no clear regional R&D strategy. The RTP and the life science clusters mentioned above promote and support R&D within their prioritised fields, but are not trying directly to influence the direction of the research conducted at universities and research institutions. Each university decides what fields to prioritise and how to allocate their means. In the long-term perspective, measures need to be taken in order to focus resources and specialise in different research fields. All in all, four challenges related to the R&D-environment in the Stockholm region concern biopharma. These are the connection between production and R&D, co-operation between educational establishments and trade and industry, the concentration on regional colleges and universities and the tendency towards a regional shift regarding companies' research efforts. The connection between research and production should not be undermined since removal of production will result in a subsequent removal of research. Generally, it is also an advantage to carry out R&D close to important customers, and since the larger markets are outside Sweden this tends to draw research activities away from the country. Therefore, it is extremely important to continue to provide policy measures that attract large pharmaceutical firms as well as new, innovative firms.

North-western Switzerland

Introduction and basic data about the region

In the centre of the trinational Upper Rhine Valley area of Switzerland, France and Germany, lies north western Switzerland (NWCH), with the core of the region found around the city of Basel. It is among the most populated areas in Switzerland, with a population of 557 000, and the city of Basel as an urban centre. Thirty per cent of the country's population – or approximately 2 300 000 people – lives in the extended region, comprising several cantons and covering 23% of the area of Switzerland.

Though the NWCH region is not a political entity in itself, it is part of the Swiss Confederation, the highest administrative level in the country and responsible for foreign and defense policy, customs and monetary policy, and other areas that are in the common interest of all Swiss citizens. Each of the 26 cantons has its own constitution, parliament, government and courts; *i.e.*, acts as a regional authority with a relatively high degree of

autonomy. A large proportion of fiscal jurisdiction is delegated to the cantons and the tax level varies between regions. Each canton is divided into municipalities or communes (at present 2 760) at the local level. Local authorities, in addition to the tasks entrusted to them by the Confederation and the canton – such as responsibility for the population register and civil defense – are also in charge of areas such as taxation, education, social welfare, energy supply, road building and local planning, among others.

NWCH's core area is not large; in fact it is the second-smallest economic area in Switzerland, covering 2.4% of the country's area and with only 7.4% of the population. The core region ranks relatively well when compared to other regions, both in terms of employment and Gross Value Added (GVA)/capita. It had 287 000 employed persons in 2000 – equal to 7.3% of the country's total workforce. The unemployment rate (3.8%) is in line with the national average and the GVA/capita (CHF 68 700, approximately 15% higher than the Swiss average of CHF 59 600) is higher than in most of the cantons. Companies in NWCH are mostly SMEs with less than 250 employees. A number of industrial branches, such as the health and public sector, the chemical industry, retail business and repair of consumer goods, services for enterprises and the building sector dominate the core area. The chemical industry is the most significant, accounting for 10.5% of total employment (*versus* 1.2% of national employment).

The biopharma sector in north western Switzerland

Accounting for 3.5% of the national GDP and 5.81% of the GDP of the Metrobasel area, an area covering the core area of north western Switzerland and the adjacent French and German regions, life sciences employed 27 800 in 2004. Regional GDP in other leading life science regions does not exceed 2%, so 5.8% of regional GDP is certainly significant. The significance of life sciences for the national economy is clearly evident in terms of GVA. The contribution of the life sciences becomes even more apparent when examining its impact on economic growth in the region,

As influential and important as it is to the trinational economic space of the Upper Rhine Valley, the life science industry is equally important to the regional industry. With more than 1.2 percentage points per year of overall economic growth in the Metrobasel region directly attributable to it, the life science industry's economic contribution is unique.

Over the past decade, life sciences have been the economic motor of NWCH, outpacing the aggregated Swiss economy (3%). Between 1995 and 2004, it grew at a steady pace in the trinational Metrobasel area: on average, by approximately 10% GVA per year. The pharmaceutical industry – of which the agrochemical industry makes up only a very small part – has experienced rapid growth in recent years; but the life science industry has grown even more.

One reason for the success of the north western Switzerland life science cluster was the general change of focus of the chemical/pharmaceutical industry towards more emphasis on its pharmaceutical segment and less focus on traditional chemical production. A great number of spin-offs were formed in the course of various mergers and restructurings among the major pharmaceutical companies. These spin offs were able to benefit from the skills and experience of their executives and scientists. The pharmaceutical industry in Metrobasel actually makes up more than 80% of the life science sector, whereas in regions such as Zurich, the medical devices sector accounts for more than 70% of value added in life sciences.

A significant number of new jobs were also created between 1995 and 2004, companies in the sector finding the region to be a dynamic centre. Large pharmaceutical companies were the major drivers in NWCH. The merger between the two Basel pharmaceutical MNEs Ciba-Geigy and Sandoz, which together became Novartis in 1996, was an important event in this context. Some business segments were sold to other firms or produced spin-offs as the merger triggered changes in the industry. To support these spin-offs and ensure they had firm foundations financially, the Novartis Venture Fund was founded. Among other consequences, the outplacement of qualified and experienced personnel created a regional stock of both business angels and consultants. More or less at the same time, Hoffmann-LaRoche began to concentrate its business activities on core competencies. The spin-offs this triggered have since developed into major players in the biopharmaceutical industry – such as Basilea and Arpida. This demonstrates the importance of: 1) the existence of MNEs, particularly large pharmaceutical firms; and 2) the importance of an environment that is supportive of entrepreneurship. The existence of different types of funding, capital, etc., is crucial in this context.

Regional governance and strategies

The regional political and administrative responsibilities are fragmented, with no unified economic development strategy. In addition, there are few institutions to co-ordinate regional policy activities, rarely covering the entire region, and with insufficient competence. A concise summary of the economic development strategies of the cantons in north western Switzerland is thus difficult to provide. Cross-cantonal initiatives are certainly rather weak and mainly oriented towards co-ordination and location marketing. The strong position of the cantons in the Swiss political system contributes to this. Still, some similarities are evident in the economic development policies of the NWCH cantons. A veritable industrial policy or micro-steering of the cantonal economy are non-existent. The emphasis is, rather, on reduction of governmental spending and taxes, liberalisation and deregulation, provision of infrastructure (especially in higher education and transport) and cross-cantonal co-operation activities related to location-marketing. As a result, a more integrated approach to economic policy in the future would be welcome.

No specific government programme covers the entire area, furthermore, either in the narrow or in the broader definition of "cluster policy". Targeted business development measures are not used in the NWCH region to support life sciences. The cantons limit their activities to creating a framework of laws and regulations that is conducive to innovative R&D, entrepreneurial initiative, firm creation and spin-offs. The MNEs located in NWCH, above all Novartis and Roche, are important assets in this strategy, but also other global players like Syngenta or Ciba Speciality Chemicals. A considerable amount of spin-off activity was sparked in 1996 by the merger of the two MNEs Sandoz and Ciba-Geigy (the result of the merger of Ciba and Geigy in 1970). SMEs in NWCH are robust because they are market-driven, not the end-product of public business development agencies.

A set of spatially restricted initiatives, as well as projects below the programme level, do exist, related to the idea of supporting cluster structures despite there being no integrated approach. Among others, these include: activities promoting life sciences by the Basel cantons and the Basel Chamber of Commerce, the BioValley project, the Metrobasel initiative conducted by the BAK Basel Economics consulting firm and the Bern Cluster Policy.

Basel and its surrounding area are home to a significant part of the life science activities in the region. With its origins in the chemical and pharmaceutical industries, this organic cluster has long been a pillar of the cantonal economies, and, to a greater or lesser extent, cantonal economic development policies have always taken this into account. The cantons and different partners, particularly the local chamber of commerce, but also the local universities, cantonal banks, business associations and other institutions, co-operatively work to support the development of the life sciences in the region, though there is no integrated cluster policy or programme to support the cluster. The following paragraphs must be seen in the light of the more specific descriptions mentioned in different sections of this report.

The Cantonal Council in Basel Town focuses its business-oriented support activities on measures that interfere as little as possible with market processes and that supplement private activities. The Life Sciences Strategy of the Cantonal Councils of Basel Town and Basel Country and the Chamber of Commerce of both cantons (Regierung Basel Stadt, Regierung Basel Land and Handelskammer beider Basel, 2004) is a recent new initiative. A joint strategy aimed at improving the locational conditions for the life sciences in the Basel area has resulted from ongoing discussions.

The Metrobasel initiative is another recent monitoring and co-ordination initiative, propelled by the Basel-based consultancy firm BAK Basel Economics and several regional stakeholders. Its principal function is a reporting one. In order to propagate the idea of a metropolitan area in the environs of Basel, all of the various projects aim to present statistical data to a wider audience. Due to political borders within the trinational area, consisting of parts of Switzerland, France and Germany, the region appears fragmented; the goal is to make the region surrounding Basel more unified, and to bring those various political entities closer together.

Georg H. Endress, a local businessman with a pronounced trinational orientation, and Hans Briner, the first president of REGIO BASILIENSIS, the Swiss organisation responsible for managing trinational co-operation at the cantonal level in the Upper Rhine Valley, conceived the BioValley initiative. Some years later, the BioValley project was established as an EU-funded, trinational (France, Germany, Switzerland) Interreg II project in the Upper Rhine Valley. It started to receive EU funding in 1997 and has since been twice extended. In terms of its spatial dimension and focus, the project is unique in north western Switzerland.

For approximately 10 years, the canton of Berne has been implementing its cluster policy. With the aim of making Berne more attractive as a location for companies within the selected clusters, Berne established four cluster organisations and two centres of competence (Berne Economic Development Agency BEDA, 2006). Two hundred and eleven thousand are employed as staff by member-companies involved in the cluster organisations; said companies being responsible for 40% of the cantonal GVA. The cantonal centre for technology and knowledge transfer, InnoBE (*www.innobe.ch*) manages the four cluster organisations, with budgets between CHF 100 and 170 000 per cluster and year. The canton of Berne financially supports each one to the extent of CHF 80 000, with all four "clusters" organised in the form of an association.

General conclusion

Of outmost importance for the positive development of the sector, the division of labour between the regional MNEs and SMEs seems to function well in the region.

Biopharmaceutical SMEs, for instance, can benefit from the MNEs in regard to the funding of clinical trial phases and the marketing of developed products through global sales networks. MNEs benefit at the same time from the innovativeness and flexibility of the SMEs. Cluster-related co-operation may even contribute to overcoming administrative borders; this is a positive aspect since many clusters in "small" regions (compared to some of the mega-centres in biotechnology) often need to be bigger in order to compete.

The BioValley project is an example of cluster-related business networking that has been established as a cross-cantonal and cross-national initiative; nevertheless, it has suffered from a lack of wholehearted co-operation.

One example of a successful cluster-oriented and cross-cantonal initiative that is active in the field of promoting biotechnology in Switzerland as a whole is the Swiss Biotech Association.

Because such approaches tend to be market-driven, their marketing has been successful (particularly the Metrobasel initiative). The importance of clusters (and cluster policies) that are bottom up is one general observation. Industry-driven clusters, rather than those driven by the public sector, tend to be preferred. But even those cluster initiatives need to have a critical mass of strategic companies as supporters, members, etc.

Due to the division of responsibilities of the federal system (central government – cantons – communities), the existence of six cantons on a rather small spatial perimeter with administrative borders and functional boundaries misaligned, and, last but not least, three countries and a trinational setting, north western Switzerland is politically and administratively fragmented. As such, the co-ordination of administrative procedures in different cantons needs to be improved. In addition, it is difficult to communicate the details of differing cantonal rules and the consequences for an investment decision in one canton *versus* another canton from the point of view of location-marketing and attracting investments. Tax competition and differing tax rates across Swiss cantons are also considerations. Lack of funding for carrying out influential economic policy strategies is another negative aspect of the territorial fragmentation. The result is a very limited perception of the cantons beyond the Swiss borders; only the major urban centres are known outside of the country. It is, moreover, a question of implementing health policies that are effective (both in terms of health economy as well as for supplying an effective structure for clinical testing). Many small regions in the global competition for talent (*i.e.*, competent researchers, managers, entrepreneurs) and capital face similar problems.

Political commitment and support for the life sciences is an additional factor that is not necessarily lacking, but needs to be improved by policy makers. Support of networking activities, innovation processes or even governmental funds are not the top priority of many firms, but rather a clear commitment of politicians to support the industry, measures that increase acceptance among the regional population and support of other policy sectors. The sector depends on it for its long-term development. Also helpful would be further PR measures aimed at the regional population and at a national and international level to show the importance of the cluster.

R&D results commercialisation should be speeded up and intensified. Universities, for example, could increase their openness to problems and research demands formulated in industry, providing the requests reach a certain standard of research interest. To increase the overall quality of regional R&D in the life sciences, more competencies and resources for universities to attract highly qualified scientists from abroad should be sought; there

seems to be an increasing shortage of engineers and qualified technicians in NWCH. A supply of highly skilled individuals across the whole value chain is a prerequisite for the long-term development of the sector.

Shanghai, China

Introduction and basic data about the region

Shanghai is the largest city in the People's Republic of China and the eighth-largest in the world. The 2000 census put the population at 17 million, including the non-official resident (floating) population of almost 4 million. Shanghai is now an international financial hub and a major destination for corporate headquarters. It is the third-busiest port in the world, following Singapore and Hong Kong, China. It recorded double-digit growth for 14 consecutive years since 1992. In 2005, Shanghai's nominal GDP experienced 11.1% growth to CNY 912.5 billion (approximately EUR 95 billion). The "pillar industries" which account for the majority of its gross regional product (GRP) include microelectronics, automotive, fine chemistry, high-quality steel, machinery and shipbuilding. It also includes prominent ICT, biotechnology and pharmaceutical and financial services sectors.

Administratively, Shanghai is a municipality that has province-level status. The municipality oversees 19 districts which are further subdivided into counties. Within the provincial government, the Shanghai Municipal Development and Reform Commission has a very broad mandate to lead economic and social development, in line with national-level goals. The Science and Technology Commission serves an important role in orienting science and technology policy as well as financing R&D and developing platforms to support the technology needs of different actors and sectors.

Shanghai possesses a number of important assets to support innovation. On many indicators, it is in fact the highest-performing region in the country. For example, public R&D investment in the region has grown quickly, from 1.78% in 2001 to 2.34% of GRP in 2005 (STCSM), albeit with a focus on basic and early stages. A number of the most prominent industrial parks, development zones and universities are located in or near Shanghai (Fudan University, Nanjing University, China Science and Technology University, Zhejiang University and Shanghai Jiaotong University). Central government policy has been a major driver behind the concentration of these resources in certain regions. It is expected that Shanghai and the rest of the Yangtze River Delta area, along with the two other major growth poles of the Pearl River Delta and the Bo Hai Rim, will drive China's high-tech industrialisation.

The biopharma sector in Shanghai

China's pharmaceutical companies are very much focused on the domestic market, and this is likely to remain so if they continue to concentrate on high-volume generics. The government is seeking to develop national champions, but they have nothing to compare with Indian companies such as Dr Reddy's. Some form of partnership with international firms could be one way to evolve, but many industry experts are cautious about recommending this to Western firms. Ernst &Young, for example, state that merger and acquisition risk in China "still may be too high for many multi-national companies to bear" (Ernst & Young, 2005). Boston Consulting Group echo this to some extent concerning biopharma, insisting that outsourcing R&D to China is a strategic choice that signals commitment to the country and can help strengthen relationships with key opinion

leaders and officials, but the report goes on to stress that this "*won't* achieve major cost-savings for global biopharma companies" (Wong, *et al.*, 2005). Despite these caveats, China does offer a number of attractive features for global pharmaceutical companies, particularly for R&D and many multi-nationals have already set up R&D facilities. The country has around 20 biotech clusters, with 500 to 1 000 biotech SMEs. Clinical trials can benefit from similar advantages to India concerning the number, variety and cost of subjects. It is also possible that if opposition to animal testing intensifies in the West, China will increasingly be seen as an attractive alternative.

Government efforts to promote healthcare insurance in urban areas and to improve health services as part of the fight against rural poverty will benefit the pharmaceutical sector, but a number of other programmes and measures will have to be implemented to assist the industry in domestic and international markets. The Chinese pharmaceutical industry suffers from a vicious circle formed by a dependence on generics, a lack of innovation, and falling prices for generics, which means less investment available for innovation (Chinese pharmaceutical companies spend less than 2% of total revenues on R&D compared with 15 to 20% for multi-nationals). This is hampering the government's initiatives to stimulate the emergence of national champions capable of competing internationally. Measures include the introduction of the policy on Good Manufacturing Practices (GMP) in 2004, based largely on WHO guidelines. The high cost of upgrading facilities to meet the new norms (around USD 3.5 million per manufacturer) is one of the main causes for the dramatic reduction in the number of companies mentioned above. Intellectual property rights were reformed in 2002 as part of China's accession to the WTO, and should help the pharmaceutical industry to attract foreign capital and stimulate innovation, and also reduce the risk that the assets of Chinese companies are seized as a result of patent violation litigation.

The life science sector in Shanghai is an important and growing sector in the city's economy. It is by employment standards quiet small though. Compared to some other sectors in the region's economy it is still relatively small when it comes to world export shares. One possible explanation is the fact that the domestic market in China probably is sufficient at present for the existing industry.

The region has over 140 foreign-controlled R&D laboratories. A rapid and continued expansion of higher education is ongoing. Shanghai now has 59 colleges and universities with a total enrollment of approximately 600 000 students. The city has 10 universities which are included in the Top-100 list, selected by the Ministry of Education; such universities receive special treatment and extra resources. Furthermore, a number of Chinese universities with expectations to become recognised as global research universities are located in Shanghai: Fudan University, Tongji University and Shanghai Jiaotong University.

The predominant part of the sector is located in the Zhin Yang science park in Pudong, established some 15 years ago. In 1993, the government decided to focus on high technology, particularly on two areas: ICT and pharmaceuticals. Since 1996, with comprehensive support from MOST (Ministry of Science and Technology) and Ministry of Health (equivalent to the FDA), among others, there has been a more formal delegation to support the growing life science cluster in the area. In the last six to seven years, a number of institutions and research institutes as well as foreign large pharmaceutical firms have located to the area (for example Eli Lily, Roche and Novartis). The Zhin Yang science park

today demonstrates every known feature of an emerging cluster. There are approximately 50 manufacturing companies located in the park, national as well as international.

Moreover, a number of organisations doing clinical research are present in the park. At present, approximately 200 start-ups, some listed on exchanges in China, United Kingdom and Singapore, are located in Zhin Yang. Finally, it should be noted that many R&D centres in sectors related to the pharmaceuticals industry are located in the cluster, for example DuPont and Estée Lauder.

Over the last 10 years, Shanghai – regardless of sector – has emerged as an important R&D hub in Asia, even globally. Moreover, some 20 government-funded R&D institutes (excluding ICT) are located in the park. ZZHTP aims to attract recognised pharmaceutical companies from overseas and from China, and to expand its R&D structure and improve its content by attracting talent. More than 120 small and medium-sized companies have already set up in the Park, which also hosts the Shuguang Hospital and the Shanghai University of Traditional Chinese Medicine.

Regional governance and strategies

Regional governance targeting innovation systems and competitive clusters in Shanghai is a somewhat complicated mix of national and regional measures.

As concerns policies to increase inputs, they can be divided into two subcategories. First, measures targeted at creating a better environment for funding, public as well as from VC companies. Second, to attract human resources. Attracting venture capital is no longer regarded as a big problem, since seed capital and venture capital are readily accessible in Shanghai. There are a lot of dynamic VC-firms and finance groups, with those funded by the government highlighted as the most important. The lack of truly private firms (particularly international) may be a problem in the long run. Moreover, another important aspect of the strategy is to develop closer interactions and to increase R&D over the next five to ten years. Biotechnology is listed in the central and municipal governments' medium- to long-term plans for support.

When it comes to measures targeted at creating a better environment for innovation, a number of strategies exist, many of them related to the role and function of government, regulations and the creation of competitive market conditions. One such example is to provide preferential policies and subsidies. Another is to invest in infrastructure and institutes and to promote high-tech parks and incubators. To attract major R&D to Shanghai, support facilities will be needed. In addition, government procurement to provide a market for the products is supported. To secure IP protection and encourage patents, associations to establish technology standards for that industry or encourage them to adopt international standards are promoted. Finally, measures aimed at developing the labour pool for innovation, from R&D-personnel to managers and entrepreneurs, are envisaged.

As concerns cluster strategies, it should be noted that the cluster concept is in the initial stage here as a proactive economic and regional development tool. With a number of industry parks, firms and other actors (related services, supporting organisations, academia, etc.) gradually realised that they could be more competitive if a formal cluster initiative was launched. On a general level, the municipality of Shanghai is more interested in technology than in attracting foreign direct investment. An important aspect of the

strategy is that the region not be just a location for manufacturing and sales, but also for cutting-edge R&D.

General conclusion

It is obvious that biotech in Shanghai is a growing sector, a sector that benefits immensely from: 1) the large Chinese market; and 2) the public systems, understood broadly, for support. Shanghai, thus, is a strong region when it comes to funding. One major reason behind this is of course related to the fact that there seems to be a fairly coherent policy concerning life sciences on the national and the regional level. Moreover, another feature which seems to have worked is the fact that competence-provision is supported. All in all, this has led to the Shanghai cluster taking a giant leap up the biopharmaceuticals value chain.

What has worked less well? Firstly, and this is a feature shared with other regions as well, is the level of academic entrepreneurship. Possibly, innovation policies are putting too much focus on input (*i.e.*, academia) and not enough on commercialisation. Secondly, it should be noted that a proper cluster strategy does not yet exist. Up to now, the model has been rather to promote science parks and technology transfer within the parks.

Concerning the implications of the development of pharmaceutical technology on Shanghai's policy making, it should be noted that the pharmaceutical industry, the biological pharmaceutical industry in particular, is a typical R&D-intensive industry. From the perspective of international experience, technological innovation activities of the pharmaceutical industry occur in the context of market-oriented competition among enterprises and are an important component of the country's state innovation system. When considering support from the government to the so-called state innovation system for the pharmaceutical industry, the major challenge involves how the government should co-ordinate co-operation among universities, research institutes and pharmaceutical companies, as well as developing technological resources, and how to tap the potential for development of biological pharmaceutical technology in Shanghai.

With regard to competition for technological resources in Shanghai's (and of course China's) domestic pharmaceutical market, the competition for technological resources is intensifying over time, especially competition from pharmaceutical powers such as the United States. In this context, one may argue that government organs and the enterprises involved should accelerate communication between basic research and technological innovation in Shanghai's biotech and pharmaceutical industry. Moreover emphasis must be given to the development of patent technology resources and control strategies, in response to efforts of foreign companies to control Shanghai's technological resources in the field of biotechnology, pharmaceuticals and medical devices.

Moreover, the Shanghai governments – on different levels – should facilitate the growth of a true cluster initiative in Shanghai, not by direct market intervention, but by supporting an efficient public sector and the quality of China's overall regulatory framework. Government should, thus, play the role of "enabler" of private business, and build on Shanghai's already-existing comparative advantages; *i.e.*, superiority of educational standards, position as a hub for cutting-edge research in China, attractiveness as a work location for knowledge-industry professionals, and position as a financial services hub.

One important implication for policy in this context is to support the creation of different types of institutions for collaboration that are a combination of efficient

government-sponsored and private-sector-led institutions focusing on serving industry needs. This should be done by promoting co-operation and networking throughout the biopharmaceutical innovation system, especially between actors in science and the business system. Thus, there needs to be a division of labour where private firms should improve their own individual competitiveness (and work together to improve the competitiveness of the overall cluster where co-ordination creates "win-win" outcomes) and the public sector which must continuously create the preconditions for an attractive environment and a growing business community by offering quality services and infrastructure at the right price, and a "business friendly" culture that encourages the creation of more companies or the establishment of offices in the region. Academia, finally, should strive for a combination of delivering globally-excellent research in combination with regionally embedded applied research supporting the firms located in the cluster.

Montreal, Canada

Introduction and basic data about the region

The Montreal region is usually defined as the Montreal Census Metropolitan Area (CMA), an area surrounding the urban core of the municipality of Montreal measuring over 4 000 km^2 with a population of 3.7 million people. In Canada, it is the second-largest urban centre; in North America it is the sixteenth-largest.

The Montreal Metropolitan Community (CMM) is a co-ordinating, planning and funding body covering (with some minor exceptions) the CMA area. Infrastructure, economic development, social housing, arts and culture promotion, the transit and arterial network, and environmental issues are among its responsibilities. A Council made up of 28 elected officials from member municipalities manages it. Eighty-two municipalities, responsible for a wide range of tasks such as urban development and zoning, urban transit, waste, water, police, and fire protection, make up the CMM. Fourteen Regional County Municipalities (RCMs), which are supra-municipal, grouping certain municipalities in a given area, are also included. The CMM contains eight of these entirely within its territory, with six partially included.

The benefits of economic restructuring have significantly benefited the Montreal area, and it is increasingly in the business of selling "knowledge". The shift from traditional industry towards high-tech industries such as aerospace, biopharmaceuticals, and communication and information technologies (CIT) characterises the industrial base with high-tech products as its primary exports. With an annual output of CAD 112 billion, Montreal CMA is the second-largest contributor to the Canadian GDP. The region's employment rate has climbed faster than that in the rest of the continent since 1997.

The biopharma sector in Montreal

A significant role in the Canadian life science sector is played by the Montreal area. In terms of the concentration of jobs in the North American biopharmaceutical sector, the area ranks sixth. Canada as a whole is ranked second world wide in the field of biotechnology, just behind the United States, in terms of the number of biotechnology companies. Canada ranks highest in terms of R&D expenditure per employee. With the Montreal metropolitan area hosting nearly half of the Canadian biopharmaceutical industry, all phases of pharmaceutical product development can be carried out locally in the region – from basic research to market launch, including all stages of pre-clinical and

clinical research. The bulk of basic and clinical research in Canada, as well as about 90% of Quebec's work in life sciences, is conducted in the Montreal area. The life science sector accounts for nearly 40 500 jobs in the region. The main fields include pharmaceuticals, with approximately 10 000 employed in drug manufacturing, and about 30 international pharmaceutical companies with their Canadian head offices in the Montreal metropolitan area (major players are Merck Frosst Canada [1 400 employed], Wyeth Canada [1 300] and Pfizer Canada [700]); biotechnology, with about 75 out of a total of 165 biotech firms in the area in the health sector and employing a total of approximately 2 100 workers; contract research organisations (CRO), with about 3 600 employed in the 16 CRO companies in the region (major players are Clintrials Bio [1 400], Recherches and Mds Pharma Services [1 100]); and medical devices, employing about 10 000 workers in the region.

Life science research is mainly conducted at the two universities, McGill and Université de Montreal, the exception being company-based R&D. With 25 institutes and research centres in the field of life science and six affiliated hospitals, McGill ranks second in Canada in health sciences. The Université de Montréal has a network consisting of 24 research centres and 10 affiliated hospitals. The fact that even though the province of Quebec represents only 23% of Canada's population, the region accounts for 68% of Canadian prescription drug patents, 42% of investments in pharmaceuticals R&D, 41% of investments in biotechnology R&D, and 32% of Canadian grants for peer-reviewed medical research, is another indicator of Montreal's importance to Canadian life science research.

The Montreal area accounts for approximately 90% of these activities in Quebec; the Quebec region receives nearly 50% of Canadian health research funding and most of the research activities are carried out in the Montreal area.

The Greater Montreal area hosts a number of major venture capital companies with experience in biotech; E&B Data lists 21, of which six are government-related and five are linked to unions. The remainder are private companies offering rounds of funding to products in various stages of development (validation, pre-clinical, early- or final-stage clinical trials).

Regional governance and strategies

Since 2002, the 27 surrounding municipalities on the Island of Montreal have merged (and some of them then demerged). The larger Montreal Metropolitan Community is in charge of planning, co-ordinating, and financing economic development, public transportation, garbage collection, etc., across the metropolitan area of Montreal. The City of Montreal is, thus, only one component of the CMM, but the president of the CMM is the mayor of Montreal.

The CMM Council, after holding public consultation sessions, adopted a new economic development plan in 2005. The plan forms the basis of the CMM's efforts to improve its international competitiveness and ranking among the world's major cities. The goal is for Montreal to become: 1) a learning metropolitan region that meets the challenge of improving training for its human capital and ensuring that the supply of skilled workers meets the demand; 2) a competitive and prosperous metropolitan region that fosters the development of metropolitan-wide industrial clusters and nourishes the dynamics of innovation; 3) an attractive metropolitan region with a modernised municipal infrastructure, consolidated urban and inter-city transportation systems and an improved

quality of life; and 4) a world-class metropolitan region with an established brand that helps promote Montreal on international markets and stimulates foreign direct investment.

The fact that innovation, productivity, competitiveness and prosperity are all interrelated is the point of departure for the biopharmaceuticals cluster strategies in Montreal. The strategies of big cities to ensure their competitiveness, as a result, increasingly rely on the development of innovative clusters, that is, a geographic concentration of firms and institutions working in a particular industry. Interaction and a free-flowing exchange of ideas and knowledge are fostered by the physical proximity of the actors.

The CMM is therefore facing the challenge of instituting a development strategy for its existing metropolitan clusters, which, for the most part, have not been able to take sufficient advantage of the business synergy among the various actors in the cluster. Finding clusters that are already active in the metropolitan area and activating them by supplying appropriate tools and opportunities is the CMM's role, not creating new clusters. In the regional strategy, the life science cluster is one of the most prominent and therefore highlighted.

Montreal International (MI), the agency in charge of contributing to the economic development of Metropolitan Montreal and increase the region's international status, was at the origin of adopting the cluster approach in the CMM with the creation, in 2001, of the 2002-2010 Action plan *Accelerating the development of the life sciences cluster in Metropolitan Montréal*. It was following this first exercise that the decision makers in the cluster's private sector signified their intention to remain mobilised in order to ensure the implementation of the plan, and the Canadian and Québec governments decided to finance the creation of a unit within MI dedicated to life sciences. Thanks to sustained efforts, both by cluster members and the MI team, definite progress was made. The cluster's actions were focused on priority transversal cases, such as access to venture capital or the improvement of market conditions for biopharmaceutical products, as well as other cases that arose, like the relaunch of activities at the Shire-Biochem laboratory or the location of the head office of Sanofi-Aventis' Canadian subsidiary.

Over the last three years, MI has worked on maintaining the mobilisation of cluster parties at a high level, ensuring follow-up on the action plan, adapting it based on changes that may arise in the environment – both local and international, energising exchanges within and outside the cluster through the *www.lifesciences-montreal.com* website, and contributing to meeting job creation objectives stipulated in the action plan. In addition to actions specifically designed to reinforce local capabilities, MI has supported the cluster's efforts to raise awareness at the two higher levels of government of the actions that are required and are essential to take full advantage of the wealth creation potential in this sector. Finally, in conjunction with all cluster partners, MI has continued efforts to reinforce the international positioning of Metropolitan Montréal's life sciences cluster, and therefore ensure expansion equal to the cluster's true strengths.

Furthermore, MI's life sciences unit has launched an initiative aimed at refining identification of world-class fields of expertise in the research environment established on the CMM's territory. During the course of the next three years, MI has leveraged the sectorial intelligence of the life sciences unit to reinforce its proactive targeted prospecting strategy in life sciences. Through this inclusive process that unites decision makers from all the links in a sector's value creation chain, MI hopes to contribute to reaching the full potential of the life sciences sector, in terms of both endogenous and exogenous growth.

Within a framework of decentralised governance involving all economic stakeholders, cluster-based action plans are being developed and implemented. The CMM does not act as a substitute for the actors and decision makers currently working in this field; it focuses instead primarily on its designated planning and co-ordination role in order to mobilise those involved and help organise all the clusters on a metropolitan scale. The task of co-ordinating a cluster's development plan – once a consensus has been reached on that plan – is assigned to what is known as a cluster initiative (or secretariat). The secretariat's role is to lead the cluster, safeguard the common vision, make good use of the competitive capital, make sure that the strategic plan is carried out and, in the process, help improve the economic growth of the metropolitan area. A competitiveness fund was created to support, in terms of financing, the development of any organised metropolitan cluster that has developed a growth strategy. Funding totalling CAD 18 million over a three-year period comes from quadripartite financing from the municipal, provincial and federal governments and the private sector.

Like Montreal InViVo, the branding name of the life sciences cluster, each cluster initiative could also develop its own website. Particularly in terms of branding Montreal as a biotech hot bed and supporting the regions' marketing efforts, Montreal InViVo was the first major cluster initiative in the region. Its bottom-up, firm-led approach is the most positive aspect of Montreal InViVo, since most of the major players are active and supporting this cluster initiative. Montreal probably also needs a more proactive cluster policy in the long run, targeted at more actively adjusting factors and structures that hinder positive development.

It should be noted, in this context, that a number of biotech hubs exist in the larger region, for example, the BioCity of Laval. The City of Laval, the National Institute for Scientific Research (INRS), and the Science and High Technology Park were conceived in 1987 by LAVAL TECHNOPOLE; as stated on the website, they were "developed to meet the needs of companies and institutions with a strong science and technology orientation and to promote inter-disciplinary dynamics in a campus-like environment". However, firms in life sciences are not predominant in the Park presently. In the greater Montreal region, the BioCity in Laval is one of the more important hubs making up the larger regional cluster (one of five poles identified by InViVo in its action plan).

General conclusion

To successfully support the biopharma industry Montreal has a critical mass of activities: four universities committed to fundamental research in life sciences, a fiscal environment conducive to such research, specialized service businesses (especially in clinical research) and the Canadian head offices of several major pharmaceutical companies distributing biotech products.

The region has, furthermore, managed to attract a number of large pharmaceutical firms R&D-centres. In order to secure a more R&D-driven regional sector, this is extremely important. All the more so, since it is evident today that large pharmaceutical firms rely more and more on buying innovations from small firms.

Montreal InViVo acts as a branding organisation for the cluster. The fact that it is a bottom-up organisation where the companies are the drivers is one of its positive aspects; another is that the Montreal strategy, or rather the Canadian strategy, seems to enjoy a coherence between national and regional policy measures. In addition, there seems to be a

recognition that it is extremely important to merge different policy fields, such as health policies and industrial policies.

One may highlight the fact, on the negative side, that one of the regional strengths is R&D in vaccines. In itself of course this is not a negative aspect; compared to other fields in biopharmaceuticals, though, vaccines could to some extent be regarded as fairly generic and easy to produce in many regions. Although at present no such signs are visible, the region could face a risk that some of the premises for R&D are relocated to other countries (China, etc.). Of course, one way to retain this competitive edge is to offer different types of tax incentives. For regions today competing in a global context, this is probably a necessary prerequisite, but it is not the only one that regions should rely on since many countries/regions offer similar incentives.

Another problem in this context is the level of salaries in the sector in Montreal. Compared to other regions, they are still lower, particularly neighboring regions in the United States. Another particular weakness in the cluster is the lack of large pharmaceutical firms headquartered in the region. The marked deterioration of the business climate in Canada for innovative pharmaceutical products is a common complaint of pharmaceutical companies, causing their head offices to be hesitant about reinvesting in Canada. Since one of the more crucial components in developing a long-term competitive cluster is the existence of a critical mass of large pharmaceutical firms and small R&D companies, this is extremely important to consider.

Several policy recommendations suggest themselves. It is important, first of all, that the region continue to work within the context of the larger region, fighting the tendency to be fragmented and muddled. It is important in this context that Montreal InViVo continues to work marketing the region and the cluster as a *regional* cluster comprised of several sub-regional technology parks/clusters, such as BioCity Laval.

R&D results commercialisation should be speeded up and intensified. Important in this context, of course, are both public funding, and different measures for attracting venture capital (as well as pre-seed capital). It should not be as difficult as it is for biotechnology companies to obtain the funding required for them to grow; the continued growth of biotechnology companies, despite a generally favourable context, is far from certain without greater availability of venture capital. The availability of sources of funds represents an ingredient that is key to the success of young firms, since such firms "consume" a lot of capital before being profitable. Although providing an attractive environment for international capital and foreign direct investment is important, it is not entirely an economic issue. The existence of managerial and entrepreneurial skills is equally important, since it is often management, not the 'research' part that is a problem in a young research-driven firm.

Attracting more skills and resources for universities to attract highly qualified scientists from abroad is another measure that could increase the overall quality of regional R&D in the life sciences. Support for measures that increase the inflow of relevant competencies (*i.e.*, providing for "the good life", etc.) is important in this regard. There is a need to continuously target issues such as housing, infrastructure, schooling, etc.

In terms of the budgets currently allocated to research, increases are to be desired. The cluster has significantly benefited over the last ten years from investments in public life science research and healthcare. The region seems to have a strong competitive edge in this area. As an anchorage point for the cluster's development, integration of teaching

hospitals is a crucial measure, as well as continuing to merge different policy areas, since health policies, etc., cannot be separated from innovation policies in the context of the life sciences.

Political commitment to support the life sciences by policy makers and other key stakeholders in the region is, in this context, an important factor. Although many firms are not in need of support for their core activities, a clear vision concerning the importance of supporting the sector from the public sector and from policy makers would be welcome. Such policy measure support is vital for the long-term development of the sector. It would also be helpful to show the importance of the cluster by further PR measures aimed at the regional population and at the national and international level. Montréal InViVo is a prime example.

Notes

1. The report draws on the study "Global Outlook for the Biotechnology Sector – Future Drivers, Trends and Barriers", prepared for OECD International Futures Programme by Patrick Love, background material provided by the case study regions and interviews with representatives from industry, academia and local and regional authorities. As preparation for the interviews, a questionnaire, focused on basic information and statistics, was completed by the region. The interviews were carried out by the sector expert in collaboration with representatives of the OECD/ Nutek Project Team. Sector experts were Peter Eklund, The County Administrative Board of Södermanlands län and Daniel Hallencreutz, Intersecta AB.

   The views expressed are those of the authors and not necessarily an official position of either Nutek or the OECD.

2. It is tackling its image deficit by spending heavily on public relations and advertising, and by funding various humanitarian projects. In 2004, Pfizer, for example, spent almost USD 3 billion on advertising in the United States, and Johnson and Johnson over USD 2 billion (see Glaeser, 2005).

3. A milestone payment is a lump sum payment that is paid by a licensee to the licensor upon certain milestone events taking place. A milestone event demonstrates that intellectual property is progressing through its development, clinical or regulatory phase, and is getting closer to a market-ready state. As the intellectual property progresses through these milestone events, the uncertainty and speculation of market entry diminishes, and the intellectual property correspondingly becomes more valuable. A milestone payment is in part designed to compensate the licensor for this increase in value. The achievement of some of the following milestones might be the trigger for the making of milestone payments: identification of a lead compound, commencement of animal studies, filing an Investigational New Drug application to the FDA or its equivalent elsewhere, commencement of Phase 1 clinical trials, commencement of Phase 2 clinical trials, commencement of Phase 3 clinical trials, product registration (see Mendes, 2006).

4. The study does not incorporate possible effects of the Medicare Modernization Act, which may reduce drug prices for seniors (see US Dept of Commerce, 2004).

5. The wide range depends on whether the calculation is based on dollars per kilogram of active ingredient or as dollars per standard dose. See page 23 of the report for fuller details.

6. Clinical trials in most countries follow a similar multi-phase protocol:

   Phase 1: A small group of people (20-30) all take the same drug but have different methods of delivery and/or different dosages to test the safety and dosage of the drug. Although usually conducted with healthy volunteers, Phase 1 trials are sometimes conducted with severely ill patients, for example those with cancer or AIDS.

   Phase 2: The new drug is compared with the current standard treatment or placebo on a larger group than Phase 1 studies (100-300 people) to test drug safety and efficacy. The people tested have the disease or condition to be treated, diagnosed or prevented, and are often hospital patients who can be closely monitored.

   Phase 3: These are large trials (1 000 to 3 000 people) that randomise patients to test the effects of the new treatment without bias from researchers. Phase 3 studies test the effectiveness of the drug as well as potential side-effects. Safety of the drug also is monitored.

Phase 4: These studies occur after the drug has been approved. Phase 4 studies may be used to evaluate formulations, dosages, durations of treatment, medicine interactions, and other factors. Patients from various demographic groups may be studied. Phase 4 studies are important in detecting and defining previously unknown or inadequately quantified adverse reactions and related risk factors. Phase 4 studies that are primarily observational or nonexperimental are frequently called post-marketing surveillance, and are sometimes known as Phase 5 studies.

7. The Swedish Agency for Innovation Systems (VINNOVA) and the Swedish Agency for Business and Regional Development (NUTEK) have been responsible for innovation systems programmes and cluster programmes, respectively.

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Globalisation and Regional Economies:
Can OECD Regions Complete in Global Industries?

PART II

Chapter 7

Regional Case Studies in the ICT Sector[1]

This chapter looks at the evolution of the mobile ICT industry and the impacts that changes in the structure of the industry are having on four regions specialised in ICT. In each case, the regions are struggling with the impact of restructuring of the global ICT industry, particularly the after-effects of the ICT "bubble". But the regions are also striving to build on the R&D strengths and innovative capacities that the regions have acquired over time as leaders in a dynamic technology-driven industry in order to maintain a competitive edge.

Global outlook

The ICT sector plays a major role in globalisation, both because it is itself highly globalised and because it enables the globalisation of other sectors. The sector is characterised by dynamism in goods and services trade, export-oriented foreign direct investment (FDI) and cross-border mergers and acquisitions (M&A), particularly in telecommunications services, a development largely driven by efficiency-seeking competition in production, with firms taking advantage of continuing cost differences and the rapid development of goods and services production capabilities, and more recently by the growth of new markets in rapidly developing eastern European and non-OECD economies (*e.g.*, China and India). Evidence suggests that there could be an enormous expansion in the global use of information and communication technologies (ICTs). In large part, this is the inevitable consequence of the continuing expansion of the global economy and the greater emphasis on services and the development of the knowledge-based economy.

The shift of manufacturing activity towards non-OECD countries especially in Asia (*e.g.*, China, Hong Kong, China and Chinese Taipei) is very evident when looking at ICT industries. For example, imports of ICT goods into OECD countries increased 7% a year between 1996 and 2004, with growth of imports from non-OECD countries much stronger (12% a year) than that of imports from OECD countries (4% a year). In the late 1990s, 70% of OECD ICT equipment imports came from other OECD countries and 30% from non-OECD countries. By 2004, the OECD share had fallen to 58% and that of non-OECD countries had risen to 42%.

OECD countries still account for most services activities and services trade but indicators of trade, FDI and the activities of multinationals also show that services are in fact globalising with many non-OECD countries showing very rapid growth. China and India already account for relatively large shares of trade in ICT-enabled services (7% of exports and around 5% of imports between them), and some Baltic and eastern European countries are increasing their shares, reflecting new global patterns of ICT-enabled services supply. However these countries' domestic services activities are also growing and adjusting to international competition and their markets offer increasing opportunities for services firms from OECD countries. Firms from developing countries, and India in particular, have begun to set up extensive global operations to deliver their services locally or regionally to clients. Overall, the location and growth of services activities depend on the quality of the services supplied as well as the ICT infrastructure and business framework. Therefore, firms and countries that are developing international services sourcing activities make efforts to improve the quality of services as well as information security and privacy.

In 2005, the global ICT market increased by 5% and the estimated value was approximately USD 2 000 billion. ICT is a significant and a major share of investment across the OECD area and the major share of venture capital flows into the ICT sector. The

top ICT firms have revenues above 20%. However, their employment is still flat and a return to the annual growth rate of 20-30% within the ICT sector in the late 1990s is unlikely.

In 2003, more than 14.5 million people were employed in the ICT sector in OECD countries, or more than 5.5% of total OECD business sector employment. Five million were employed in manufacturing and 9.5 million in services. The employment growth was almost 8% (over 1 million people) over 1995-2003, but in most countries it remained approximately stable. Countries with the largest relative employment increases were Finland, Norway, Denmark, Sweden, Hungary and the Netherlands.

Even though Europe is a world leader in several fields of ICT, especially telecommunications and mobile technology, the European share of the global market is rather limited. Despite that, the sector is a cornerstone of the European economy, comparable to industries such as automotive or pharmaceuticals. Within the EU (EU15), there are about 700 000 ICT enterprises with 7 million employees; of them, 5 million in ICT services firms and 2 million in manufacturing companies. The sector accounts for 4-6% of the entire employment in the EU. In Finland, the Netherlands and Sweden, the sector share of total business employment is higher than in the United States and comparable to the EU average (see *www.culminatum.fi/content*).

In the four case study countries (Brazil, Canada, the Netherlands and Sweden), the trend is towards an increase in the number of companies and employees within the ICT-related service sector, while employment is declining in manufacturing. However, the Netherlands is more competitive in specialised manufacturing (embedded systems, semiconductors, high tech and materials) than in services, while the hardware sector accounts for 50% of the turnover of the Brazilian ICT industry (see *www.mait.com*). Despite the worldwide sector downturn in the early 2000s, the ICT service industry in Canada has experienced persistent growth since 1997. The software sector is expanding in Brazil as well as in Canada.

Key drivers and trends

On the manufacturing side of ICT, the sector consists of semiconductor suppliers, software suppliers, systems and networking suppliers and system integrators. In addition, there is a broad range of services in consultancy and maintenance. Future major changes within the ICT sector as a whole can be expected to be driven by mobile technologies, due to their great market potential as well as great technical potential.

The mobile industry can be seen as a sub-sector of ICT. The global market value is estimated at between USD 500 to 600 billion, and the market is fast-growing. Of eight countries with trade surpluses in ICT, five (South Korea, Finland, Japan, Sweden and Ireland) are leaders of mobile technology exports. Competitive industry R&D clusters are operating primarily in Cambridge, Helsinki (and Oulu suburb), Tel Aviv (and Herzilya) and Taiwan, while handset and network production clusters are expanding in China, for instance Guangdong province and Shanghai, and semiconductor manufacturing in low-cost areas in northern and eastern parts of the Chinese mainland. Small suppliers of mobile software are emerging and growing around large MNOs and network equipment suppliers, such as the United Kingdom's "M4 corridor", close to Vodafone and suppliers such as Lucent and Nortel, or Stockholm, close to suppliers and operators such as Ericsson and Telia Sonera, respectively.

The first production centre was in the United States, while Europe emerged as a production centre only in the latter-half of the 1980s, following digital systems

introduction, and specifically GSM. This led to new centres of production for GSM handsets and network equipment products, principally in Finland, Sweden, the United Kingdom, Germany, France and the Netherlands. Japan produced largely for its own market, as did South Korea originally. Finland and the Nordics' early lead in production was mainly due to the growth of their local mobile markets as well as socio-economic factors such as dynamic regulatory regimes that positively encouraged the new technology, the real need for ubiquitous communications, driven by the large land mass of the countries, compared with small populations which needed more than fixed-line service, reasonably high disposable income to afford such services, and later, the realisation that the technical advances in mobile formed a viable export industry with high added value.

Since then, offshoring has arrived in regions and countries that offer a manufacturing ecology of components and some technical expertise in integrated circuits and radio engineering, low-cost labour for assembly and testing, and a highly skilled workforce. In the late 1980s in Taiwan and Singapore, moving on to lower-cost production centres in mainland China, Malaysia, etc., in the 1990s. Korea only realised its major exporting success with Samsung and Lucky Goldstar (LG) products after 1998, following the Asian economic crisis.

Today, the European industry relies on a few large contract suppliers for sourcing whole units and key components, as in the PC industry and handset industry. However, except for commodity items such as base stations more specialised network equipment has been slower to be offshored. Software production for networks is also being offshored to software hubs such as Bangalore where the largest software factories are located. However, much of the more highly complex software which is state of the art is still being produced in Europe, and some in the United States, with media software being produced in most developed economies by specialised niche suppliers.

The mobile industry is dominated by the MNOs who tend to direct technical development as well as respond to it, often through international and industry technology standards-setting. Thus we see alliances of suppliers and operators in a set of main industry groupings, often around a technology, as it is only here that all of the players' interests in collaboration may coincide. The three main categories of players are: mobile network operators (*e.g.*, China Mobile, DoCoMo, Orange and Vodafone), handset suppliers (*e.g.*, Nokia, Samsung, Sony Ericsson, Symbian) and network equipment suppliers (*e.g.*, Ericsson). The largest operators are Vodafone, China Mobile and China Unicom. China Mobile is, as a whole, the largest MNO enterprise with 252 million customers, while Vodafone is the largest globally operating company with 155 million subscribers in 26 countries. In early 2006, the global market comprised 2 billion customers, compared to 1 billion people connected to the Internet.

The industry is, to a great extent, governed by operators, some operating world wide while others are focused on national markets. The mobile market is partly regulated, but not as regulated as fixed-line telecommunications.

Despite being a highly secretive industry, the MNOs may have interests in new technology start-ups in software, semiconductors, handset design, signal processing, etc., and may seed new ventures wherever this is to their advantage. As the mobile scene becomes more complex with the appearance of content players, alliances are constantly shifting. In order to be competitive, the largest operators finance "proof of concept" trials of new technology, sometimes in very large pilots with national coverage without revealing

the projects and their results. Security for deployment, commercial or technical purposes is akin to the pharmaceutical or defence industries at the top level of advanced studies.

Key drivers shaping the industry

There are two main drivers of development: demand and technology. Demand-driven (technology pull) can primarily be derived from the level of disposable incomes and the number of potential customers; however, demand-as-driver also includes more hidden factors such as shared values, life expectations and lifestyle.

Technology-driven (technology push) development can mainly be of two kinds. Firstly, through improvements of existing technology or new technology responding to customers' needs and problems, secondly, through improvements of existing technology or new technology creating new needs and demands. Moreover, improved technical solutions or new solutions may also meet existing demands more efficiently and be cheaper than those already available on the market.

The demand for mobile solutions has been increasing rapidly in the last decade. The largest growing market potential is expected to be within developing countries, so-called newly industrialised countries (NIC), with an expanding middle class and increasing disposable income. The largest future markets are expected to emerge in Asia, primarily China and Latin America. In 2020, according to one forecast, more than 60% of a population of 8 billion are expected to use mobile technologies in some form.

In the last decade, mobile technologies have had a dramatic impact on the distribution of production, goods and services, as well as on people's everyday life. Increased accessibility and independence of time and space are characteristics. As infrastructure, mobile technology is light, flexible and relatively cheap, at least compared to fixed-line telecommunications. Most mobile technologies are aimed at mass markets. Competition and ongoing technical improvement will make the devices, as well as communication, even more efficient and cheaper. In a decade, prices of handsets are estimated at USD 10-20, and tariffs for communication are expected to become "near-zero".

Consequently, future businesses will emerge mainly in content, services and in new devices necessary to make use of new offerings. Therefore, services market opportunities are expected to emerge, for instance within communication in itself, business services (the Internet), entertainment (IPTV and games online) and lifestyle (education, elder-care and healthcare).

The public sector can also be a driving force as an influential procurer, although until now having been a follower rather than a leader. With mobile becoming part of the citizen's lifestyle context, public procurement will drive new mobile services, particularly in the areas of care of the frail and elderly, health and security/emergency services,[2] following new progress in "alternative wireless technologies", AWTs. Not only will the public sector have a strong incentive to use mobile ICT to develop new services, this factor will be expanded by the network effect of the numbers of trained public sector ICT users requiring mobile support. In some countries, where it has had specific mobile technology created for it (such as the Tetra mobile systems for emergency services) it has even reverted to commercial public services, due to the limited success of the specific technology.

Traditional public service sectors will tend to revise and create new types of services and operational entities, such as those for home support and monitoring of frail and elderly patients, turning ordinary homes into sheltered housing, remote voting, etc., with

next generation mobile and ICT technology. Public-private partnerships (PPPs) could play a role in this development; but since the success of such ventures has been highly variable, while the track record of mobile or telecommunications PPPs of any kind is sparse, it is still questionable.

In summary, if a dramatic increase of demand, through increasing disposable income, is assumed to become the driving force of the development of the mobile industry, six key factors may be the pre-conditions: lower prices per unit and distance, an increasing number of middle-class people, convergence between technologies (new services opportunities), collaboration between fixed-line and mobile operators, consolidation (mergers or acquisitions) among operators as well as suppliers, and growth of machine-to-machine traffic. Public procurement will also be an important driver behind new mobile services, particularly in the areas of care of the frail and elderly, health and security/emergency services, following new progress in "alternative wireless technologies", AWTs.

Trends for the future

The shape of the new mobile industry will be heavily influenced by the move to telecommunications and media as one offering, and the coalescence of mobile and fixed-connection into a single service that appears seamless. Production technology will change rapidly to provide lower-cost units and network elements, as low-cost semiconductor processes – for example printing transistors and complete computer systems on plastic for RFID tags and lower-cost handsets (even disposable units) – become industrialised.

Pricing of both mobile services and products will have to decline, towards what have been called "near-zero tariffs" in order to fit with the expected income levels in the developing world. The impacts on the enterprise value chain will reshape the mobile industry. The supplier and the operator will focus on core competences and retain control over quality with as much outsourced as possible as the margins on tariffs are so low. Such concentration on the leading edge will tend to put Asia at the centre of mobile product manufacture. Countries such as Viet Nam, Malaysia, Thailand and eventually Indonesia and the Philippines will become lower-cost Asian centres for sophisticated products, while Bangladesh and others move in at the very bottom of the industrial cost scale. Four major factors can be understood as incentives for offshoring: highly skilled labour, relevant expertise in radio engineering and integrated circuits, good logistic flow of components and low labour costs for testing and assembly.

The revenue and profits goals for the high volume of units sold will be set without high margins as basic unit costs are so low – this has already paid dividends in the broadband market, where lowering overall pricing has expanded the market to a non-linear degree.

Consumer-accepted advertising is seen by many as the new growth area. Through competition in multimedia, this low pricing and restructuring will also impact other players and segments – fixed-line operators and cable TV operators, also Internet players such as Google buying into mobile, and media conglomerates such as News Corp buying into WiMAX (Van Duyn, 2005).

The business model for the devices' supply chain will follow the same pattern with sourcing of semiconductor component fabrication, as well as circuit and unit assembly, wherever the lowest-cost labour with the skills level necessary can be found. Logistics will be a key factor since sourcing will be world wide, leading to concentrations of manufacture.

There is also a trend of moving R&D from the operator's or the supplier's headquarters to places where major businesses are operating. It follows the same pattern as the automotive industry, establishing, for instance, design studios close to expanding markets. Some foreign handset and network equipment companies have made investments in R&D labs in China.

Future locations of the industry

In many countries, globalisation and the international rationalisation of production might lead to increasing specialisation in ICT production or other products. In general, countries that specialise in ICT production increasingly do so, while those that do not are becoming less specialised. Hungary, the Czech Republic and Turkey have increased their share of ICTs in merchandise exports rapidly with the establishment of manufacturing facilities in eastern Europe and already relatively specialised countries (Korea, Finland and the Netherlands) have increased their specialisation as well. It is evident that the boom and bust cycle in particular sectors (*e.g.*, communication equipment), firms (*e.g.*, Ericsson, Nortel and, perhaps, Marconi) and countries (*e.g.*, Sweden, Ireland, the United Kingdom) has had an impact. Between 1996 and 2004 half of the 26 OECD countries for which data are available increased their specialisation in ICT production while that of the other half decreased.

It can be assumed that innovations within new mobile technologies and services would be driven by Asian countries, primarily China and Korea. Korea, through its projects for ubiquitous coverage, serving as national experiments for high added value export products and services. China, with its massive manufacturing capability being leveraged to gain intellectual property and so advance up the value chain into design, original R&D, and also into media content for the Asian market. Other countries like Malaysia, Thailand and Viet Nam may become low-cost areas for rather sophisticated supply goods. Altogether, it will imply that Asia become the centre and growth pole of mobile product manufacturing.

Probably, there will be moves from current concentrations of mobile design, for instance, in Cambridge and the "M4 corridor", to rapid growth markets in China. Huge investments in R&D labs have already been carried out by, for instance DoCoMo, Ericsson, NEC and Nokia. Moreover, in early 2006 Motorola's venture capital firm had invested in three Chinese wireless firms.

Globalisation also reinforced the consolidation of the ICT sector. In the last years, acquisitions and mergers of ICT companies have increased significantly. In 2005, more than 2 500 major technology and telecommunication deals were announced, an increase of 30% compared to the year before. Private equity firms are usually the drivers of consolidation.

There is an increasing capital flow in the opposite direction: from Asia to the Western world. Their companies are interested in merging with brand-name corporations, providing prestige and access to the European market. The Chinese government is a powerful actor in the market of acquisitions of businesses in Europe and the United States, not only ICT, but also sectors such as automotive, white goods and textiles. The strategy of the state-owned companies is to create new indigenous enterprises, reduce dependency on foreign technologies and push the growth of new national champions.

Clustering can be expected to emerge at future growth poles of mobile technologies. Among some public policy makers, there is a strengthened awareness of the importance of

public support (interventions) of cluster development. With Korea's success story as "best practice", governments in developing economies will probably offer incentives to accelerate cluster growth. Key clusters will grow around production centres in China, for instance, in Guangzhou and Shanghai, as well as software clusters in India, for instance, in Bangalore, Chennai, Hyderabad and Mumbai.

The rapid growth of mobile technologies and the expected growth potential in Asia the next 10-15 years imply threats to, as well as opportunities for, the four case study clusters. All the case study regions have linked to global innovation networks, mainly through MNEs. For example, the Ottawa Wireless Cluster and Nortel's presence in the Asian Pacific for three decades is providing valuable experience of government policies, market preferences and cultural circumstances, as well as knowledge spillover generated within R&D labs, but also knowledge created within the deployment of commercial projects.

However, development in Asia has also had a negative impact on indigenous clusters with more of the expansion occurring abroad while home base operations stagnate. Regions need to compete for skilled labour, market themselves and attract and retain companies and a skilled-labour force.

Eindhoven, The Netherlands

Introduction and basic data about the region

Eindhoven is situated in the province of North Brabant between three main metropolitan areas and strong economic centres: the Randstad in the Netherlands, the Ruhr area in central Germany, as well as Brussels and Antwerp in Belgium. About 2.5 million people live in North Brabant.

The city-region Eindhoven includes 21 municipalities and has around 727 000 inhabitants, 32 000 businesses and 333 000 jobs. The region accounts for almost 5% of the employment in the country and more than 4% of the GDP. The rate of employment is around the national average, but one of the highest in Europe. About one-third of the population has some kind of post-secondary education (Eindhoven region, 2007).

The Eindhoven region is the national industrial centre and the province of North Brabant accounts for almost 30% of the jobs in Dutch industry (Top Technology, 2003). About 50% of the companies are in the medium- or high-tech sector, which is well above the national average. The four key economic industry sectors are: automotive, ICT, mechatronics and medical technologies.

The industry has a strong international orientation with a large share of national exports and many multinational corporations in the province. As a whole, there are about 1 000 foreign companies and 75 000 employees in the Netherlands, with 300 companies and 19 000 employees in Eindhoven. Ten of the companies are among the 100 largest in the world.

The province has been very successful in attracting foreign investors. In the last ten years about 30% of foreign investment in the Netherlands has been in the south-east part of the country (Top Technology, 2003).

The city-region of Eindhoven has a solid knowledge base, for instance, an ample highly educated labour force and globally competitive facilities, for instance, in education (the Eindhoven University of Technology and Fontys University of Applied Sciences), in research (Centre for Microelectronics, Eindhoven University of Technology, TNO Centre for

Industrial Research and the Embedded Systems Institute), in innovation (High Tech Campus Eindhoven and Holst Centre).

This knowledge-intensive environment has been very successful in attracting R&D investments. The R&D level in the province is reaching nearly the goal of the Lisbon Agenda (2.7% of GDP). Over 45% of all private R&D expenditures occurred in the south-east of the Netherlands, whereof the Eindhoven region is the nucleus or true hot spot (see *www.brainport.nl*). From the perspective of R&D intensity (labour cost per job), expenditures in the Eindhoven region more than triple the national average.

Like most countries, the Netherlands is vertically organised in three public policy making and governance levels: national, provincial and municipal. The sub-national sectors have a wide range of tasks with municipalities having more responsibilities than the provinces.

On the regional level, the province is the representative of national government, but is also responsible for co-ordinating policy areas such as culture, education, healthcare, social affairs, spatial planning and the regional network of roads.

The municipality is responsible for education, environment, healthcare, housing, local planning, public transport, social affairs and economic development. The municipalities share many areas of responsibility with the national government, but the municipal authorities are allowed to act rather independently. In some cases, the national government has a strong impact on the local agenda, since it imposes the national framework, such as legislation, instructions, rules and norms that the municipality must follow.

In-between the formal municipal and regional levels there is horizontal co-operation, for instance, between municipalities. Officially, the province has the mandate to invite municipalities to form a city-region. Since 2003, the formation is based on the Joint Agreement Act (WRG plus-region). The main responsibilities of a city-region and its regional council are in policy areas such as the environment, housing and regional economic development, but there is a strong emphasis on traffic and transport. The budget is funded by the municipalities. Responsibility for the daily operations of, for instance, regional development, is usually that of a certain agency.

The ICT sector in Eindhoven

The strengths of the Dutch ICT industry are primarily in materials and equipment, semiconductors and embedded systems. Nanotechnology is a fast-growing area (10% a year) as well as embedded systems, whereas the sector is less successful in services development. Dutch ICT companies are less competitive in mobile phone technologies. However, the Dutch ICT industry in micro-nano electronics and embedded systems is unique because companies and research institutes, like Philips, ASML, NXP (former Philips Semiconductors), FEI, Embedded Systems Institute and Holst Centre, cover the whole value chain. Philips is operating in many various fields and world wide, but the company has still its major activities in Eindhoven.

After the downturn in the early 2000s, about 45 000 jobs disappeared, of which between 5 000 and 6 000 were in Eindhoven. In terms of employment, the sector is still suffering from the crisis and the figures are below the levels of the late 1990s, but the number of firms is increasing; *i.e.*, recovery without any new jobs. In 2005, about 35 000 ICT companies employed almost 260 000 people, with 127 000 in the software sector, 65 000 in

communication technologies and 67 000 in hardware manufacturing (Eindhoven Region, 2007).

The south-east part of the Netherlands (the Eindhoven region, North-east Brabant and the province of Limburg) makes up 20% of ICT employment and the city-region of Eindhoven itself accounts for about 7% (20 000 jobs).

To improve productivity, competitiveness and profits, a continuous restructuring is going on within companies and between companies. One major trend is an increased focus on companies' core businesses leading to outsourcing and offshoring parts of the supply chain.

Philips is a powerful engine and a strong magnet in the region and has contributed greatly to the development of Eindhoven as a national centre of electronics, and simultaneously to attract other companies to move to Eindhoven.

The company has been in operation in Eindhoven for more than 100 years, starting as a lighting producer. In 1925, Philips was involved in the first experiments with television and radio. About 50 years later, the company made key breakthroughs in processing, storage and transmission of images, sound and data, leading in the long term to the invention of the compact disc. Today, Philips is the largest manufacturer of semiconductors in Europe. In the fertile context of Philips, there have been successful spin-offs and spin-outs, such as respectively FEI and ASML and NXP (the Philips Semiconductor division that became independent in September 2006).

Though Philips is in operation world wide, the company still has its major businesses in Eindhoven. At the end of the 1990s, the company decided to move all R&D activities to one place and in the timeframe 1999-2007 has invested about USD 700 million in High Tech Campus Eindhoven. However, the company has moved its headquarters to Amsterdam, partly due to lack of qualified labour with specific skills. Yet, not many companies have moved from Eindhoven. On High Tech Campus Eindhoven the open facilities centre Miplaza was equipped with state-of-the-art facilities, such as laboratories and clean rooms. It is fully owned by Philips, but it is opened up to other companies, partners offering open innovation opportunities to pre-competitive R&D. Miplaza employs some 250 to 300 experts in ICT representing 10% of the ICT experts on High Tech Campus. As a whole, more than 3 000 people are employed in the ICT sector at the High Tech Campus.

Regional governance and strategies

In the fields of regional governance and regional development, the vertical collaboration between central, provincial and municipal levels represents a distinctive feature, while the national government is focused primarily on innovation system issues.

The national government has taken two initiatives of great importance for the city-region of Eindhoven, and the provinces of North Brabant and Limburg: Peaks of the Delta and Point One, focusing on the Eindhoven-Leuven-Aachen Triangle. From a national perspective, there is a change of strategy for regional development. The government wants to invest in certain regions with the best possible impact in order to achieve the Lisbon goal. However, national initiatives tend often to create projects which do not always correspond to the regional level's needs. Two national innovation initiatives have been taken to promote sector specific regional policies, namely Peaks of the Delta and the Key area strategy. The first is definitely a change of perspective on regional development from bridging disparities between regions to focusing on potential clusters of science-based and business-based knowledge where best synergies for growth are expected. Thus, that

means that the national focus is moved from "lagging behind regions" to growth poles of tomorrow. In 2005, the national initiative was transformed into a regional programme for the south-east part of the country.

The Key Area strategy is a national government cluster policy initiative focusing on hotspots of a set of new businesses such as creative industries, flowers and food, high tech systems and materials and water engineering and protection and chemistry. In the high technology sector, embedded systems and nanotechnology are assessed to have a great potential. Point One is the first innovation programme within the high tech systems and materials key area aimed at nano-electronics and embedded systems and is a response to three challenges of the Netherlands: 1) to become too dependent on imports from the United States and Asia; 2) to become a net importer of technology and products; and 3) to lose highly qualified labour. The initiative has a national approach to collaboration with European hotspots in nanotechnology and embedded systems. The city-region of Eindhoven is one the hotspots. The vision is to create a world-class network with a Silicon Valley reputation. Therefore, the Point One Foundation wants strategic collaboration with *Pôle de Competitivité* in Grenoble and Paris and centres of excellence in Leuven and Dresden in order to become an exporting region. The Dutch approach has been more focused on linking to EU roadmaps and cross-border collaboration than, for instance, French clusters which focus more on their own activities.

The tasks of the regional level (province as well as city-region) are co-ordination and collaboration between partners. The municipality is also responsible for spatial planning; however, it has to fit into the provincial planning process. The province has limited money available for innovation policy and cluster policy issues.

From a regional economic development perspective, the city-region of Eindhoven (SRE) is a more important and powerful actor in horizontal collaboration. Issues of great priority for the city-region of Eindhoven, SRE, are regional development, traffic and transport, but also the environment, socio-economic conditions and co-ordinated collaboration between its 21 municipalities. The SRE is funded by the municipalities. However, both the province and the city-region have a more strategic role in that they initiate, stimulate, encourage and foster regional development by different plans and programmes. Economic development is a responsibility of the Brabantse Ontwikkelingsmaatschappij at a provincial level and of NV REDE at the level of the Eindhoven Region. On their agendas, the agencies have issues such as assistance to potential foreign investors, provision of venture capital to innovative companies, as well as promotion of R&D programmes and innovative industrial projects in order to help companies to speed up the commercialisation process.

The SRE could be seen as programme initiator and promoter, but not as a programme manager. For instance, in 2002 SRE initiated the Horizon Programme – with a strategic regional action plan – whereas the implementation was carried out via a contract with NV REDE but with an independent programme agency and triple helix steering committee. Two years later, the SRE launched a new programme for economic development: Brainport. Other programmes were initiated and carried out on a regional level, for instance, Stimulus, at the beginning of the 1990s.

There is an explicit regional policy targeting the knowledge industry. Public authorities and policy makers are focusing their efforts on general approaches, strategic actions, plans and programmes to support the high-tech sector as a whole.

As a response to the economic crises in the early 1990s, the city-region of Eindhoven (SRE) set up a knowledge improvement strategy. Problems were caused by the redeployment and diversification among the subcontractors of large companies, such as DAF and Philips. The Stimulus programme, partly funded by the EU, was launched in 1994 and was focused on micro-clusters rather than macro-clusters. The programme set up incentives targeting SMEs, for instance, regarding investments and exports, as well as commercialisation of inventions, in order to increase the number of new high-tech-based companies and to establish a high-tech campus.

At the end of 2001, the city-region of Eindhoven (SRE) initiated the triple helix based Horizon Programme, which focused on four core issues: improving labour supply, speeding up commercialisation of high-tech-based inventions, and applying new technology to a wider range of economic sectors in order to decrease the region's cyclical sensitiveness. The fourth task was to improve the branding and global marketing of the city-region of Eindhoven (SRE). The programme was intended to promote economic development as well as, over time, the knowledge infrastructure of the cross-border Eindhoven-Leuven-Aachen-triangle (ELAt).

The programme was funded by the SRE and for a small part indirectly by the province. So far, Horizon is considered to have been successful and has also been a model for the next regional programme for economic development: Brainport.

The Brainport Programme – based on the title given to the Eindhoven Region in 2004 in two national government memorandums – is aimed at strengthening the economic development as well as the knowledge infrastructure of the ELA-triangle. Brainport covers 21 municipalities in southeast Brabant but has a wider geographic scope than the boundaries of the administration. It is public-private funded by its triple helix partners and is run in parallel by activities of the regional agency (REDE).

Brainport works as a development platform promoting vertical collaboration between governments and authorities on different levels, as well as horizontal collaboration between companies and research and knowledge institutes within the region, and between different regions. However the province has not much money to spend on clusters and innovation systems.

The major role of Brainport Eindhoven is to enable and to facilitate strategic economic development. Some important issues on the agenda were: promotion of open innovation (collaboration on an international level between companies and research institutions), create centres of excellence, a balanced labour market, attracting venture capital, improvement of manufacturing companies' conditions in order to attract new investment and strengthening the knowledge exchange between medium-sized and small firms.

General conclusion

The city-region of Eindhoven (SRE) is one of the most knowledge-intensive areas in Europe; regarding R&D expenditures it is nearly meeting the Lisbon Agenda. Regardless of which indicators are chosen, Eindhoven and its Brainport are assessed as one of most innovative regions and programmes in the EU and also very competitive from a global perspective. The output of the system, such as scientific citations, patents and new companies, is far above the national and/or EU average.

As confirmation of its innovative capacity, the province of North Brabant is ranked 20th on the European Regional Innovation Scoreboard 2006 (and improved its index value

over time). Moreover, on the World Knowledge Competitiveness Index, the south of the Netherlands is listed as 15th in Europe.

The city-region of Eindhoven (SRE) is providing coherent strategies and facilities for commercialisation. It represents 43% of all Dutch patents and 10% of all techno-starters (see *www.brainport.nl*). Moreover, in terms of patents (patents per million workers) the province of North Brabant outranks other European high-technology regions.

The city-region of Eindhoven (SRE) has put much effort into strengthening its profile as an ICT region and in branding it world wide. The overall goal is to become a "top technology region". "Brainport Navigator 2013: Beyond Lisbon!" sets the overall public cluster policy agenda. There are no explicit cluster policies addressing a particular high-tech sector, the approach is somewhat broader, also aiming at cross-cutting and convergence of high-tech sectors. The city-region of Eindhoven (SRE) is drawing up a framework with a broader perspective of an innovative region with its existing clusters, for instance in automotive, ICT, mechatronics and medical technologies as prerequisites, as well as targets in cross-boarder innovation systems in which Eindhoven is the locomotive. Guided by the motto "*Think European, act local*", the region is building and strengthening inter-municipal, inter-regional and international networks, as it simultaneously takes initiatives supporting the local environment. The overall guiding principle is triple helix co-operation between the public and private sector as well as academia.

Development plans and programmes are focused on functional regions, not clearly defined by administrative borders. One of the aims is to improve the possibility of EU-funding, another to increase "critical mass", strengthening its capability to attract investment as well as human resources. In a cluster context, Brainport is expected to become an innovation system facilitator, mainly initiating and promoting in two areas: networks and facilities on local-regional levels, and strategic alliances inter-regionally as well as cross-border networks internationally.

The industry has played a crucial role in building a cluster environment in Eindhoven and in the extended region. Philips has made enormous investments in R&D and has also initiated cross-border collaboration, for instance within the ELA-triangle (Eindhoven-Leuven-Aachen). Moreover, Philips has contributed to a lot of spin-offs and spin-outs, and by them thousands of jobs, and has opened up R&D facilities to external partners. Today, the open innovation model[3] is considered a strategic piece of the cluster puzzle and has opened up improved collaboration between companies (large as well as SMEs) and between the industry and research institutions. Apart from spin-offs, small companies seem to have difficulties speeding up their product development.

In 2005, a new research institute, Holst Centre, was set up by TNO in the Netherlands and IMEC in Belgium and co-funded by the Dutch and the Flemish governments. R&D is carried out in the spirit of open innovation and the ELA-triangle is one the networks that will be used. The centre's focus is more market-oriented than the universities' and the ambition is to be up to ten years ahead of the market. However, since most of R&D expenditures are private, the cluster is very much dependent on large companies' ability and willingness to invest in experimentation and development. Large companies are more inclined to join R&D programmes initiated or run by universities, but SMEs are spending an increasing amount of money on R&D.

The relocation of high-tech manufacturing may perhaps weaken the dynamics of the cluster. The national government's interest in innovation policies and high-tech is

regarded as low; moreover, public policy makers too often associate high-tech with the chemical industry. The contribution of nation public investment in R&D in the region is three times lower than is needed according to the Lisbon Strategy.

Education programmes have so far secured an adequate supply of highly qualified people in various fields of technology, but the supply of highly skilled workers and the attractiveness of the region are key issues for future growth. Moreover, the region's preparedness to develop and utilise newly emerging converging technologies seems to be good. Collaboration between the private and public sectors and academia, has been a guiding principle for the programmes mentioned above, and seems successful.

The strength of the city-region of Eindhoven (SRE) strategy is to some extent also its weakness. As long as there is a consensus about the vision and the allocation of resources, the city-regional alliance will work.

Vertical policy collaboration is still a weak link. It depends very much on scarce resources on the provincial and national level. Some criticism has also been raised towards the national government's lack of interest in innovation and development. However, one constructive response to the dissatisfaction with the government was Philips' investments in High Tech Campus Eindhoven and Miplaza.

To attract more manufacturing high-tech companies to Brainport and build a world-class innovation system (with Silicon Valley reputation) in nanotechnology and embedded systems, the problems of regional attractiveness and labour supply have to be solved and public investment in R&D needs improvement.

Ottawa, Canada

Introduction and basic data about the region

Ottawa is the capital of Canada and is situated in the province of Ontario. The provincial capital is Toronto. Ontario has about 12 million inhabitants. Greater Ottawa has approximately 1 million people, with 800 000 in the urban area. Ottawa is growing faster than the province and the country as a whole. The trading zone crosses a provincial boundary, with Ottawa in Ontario and Gatineau in Quebec. The population of the regional two is 1.3 million. By far most of the ICT companies and employment are on the Ottawa side, but the labour force is split, with many workers living on the Quebec side because of more affordable housing.

The workforce in Ontario is estimated at some 6.5 million people. In 2006, about 95 000 new jobs were generated. Ottawa has 435 000 jobs, with about 67 000 in technology-based companies, corresponding to around 15% of the labour market. Between 1999 and 2003, approximately 58 000 new jobs were created or an increase by almost 15%. The level of unemployment is roughly 5% which is far below the national average.

The province of Ontario accounts for about 40% of Canadian GDP and Ottawa's annual growth rate has been high compared to the national average. Ottawa has gone through a radical transformation from a natural resources-based economy to a federal government service capital and, in the 1990s, to a top high-tech metropolitan area.

Canada is a federal state with ten provinces and three territories. There are three vertical levels of governance: federal government, provincial government and municipal. According to the Constitution, the province has sovereignty in relation to the federal level. In theory, the provincial authority has a far-reaching mandate to govern, control and

support municipal administration. Since the provinces are free to create their own local administrative structures, Canada has around ten different municipal systems, although they share many common features.

Federal regional development programming is based on delegation to three federal agencies. Regional development is considered a shared mandate, with federal and provincial governments in complementary roles. Therefore, federal agencies operate in parallel with provincial government organisations and often in partnership with them.

The basic mandate of local governments concerns, for instance, systems for transportation, water supply and sewage treatment; but localities are also responsible for economic development and urban planning. To deal with growth-management issues, the large urban centres have a two-tier municipal structure: so-called regional municipalities, which are under the province's supervision (Meligrana, 2000). The upper-tier level is responsible for policies in common with adjacent municipalities which form the regional municipality.

In 1969, Ottawa-Carleton formed a regional municipality with a two-tier administration, and in 2001, the Regional Municipality of Ottawa-Carleton, with six cities, four townships and one village, was merged with the city of Ottawa, a city with a single-tier administration.

The ICT sector in Ottawa

The ICT sector is a strong locomotive in the Canadian economy. In terms of sector output, contribution to GDP and employment, growth rates are higher than the national averages. In 2006, about 32 000 companies in Canada employed 600 000 or 3.6% of the work force.

Approximately 75% of the companies are in software and computer services businesses. The manufacturing industry accounts for less than 10% of the companies. Small firms are dominating, with about 120 enterprises with more than 500 employees.

Despite the sweeping downturn in the early 2000s, the sector has experienced steady growth in the last 10 to 15 years. For instance, since 1997, sector output has increased by more than 100% which is three times more than the economy as a whole. A general recovery after the downturn is apparent; since 2001 sector output has increased by 30%.

The ICT industry accounts for 6% of GDP. Since 1997, the sector's contribution to GDP growth has been 12%. In 2004, the manufacturing industry was the most important contributor (44%) to sector output while the sub-sectors such as wireless communications equipment and electronic components showed the highest growth rate. ICT service industries have shown continuous growth; in 2006, output was 128% higher than in 1997 and growth tripled compared to the services sector in general. Telecommunication services have experienced persistent growth (86%) in the last nine years.

Two-thirds of the exports go to the United States, but the share is decreasing following the downturn. The fastest growing market is in Asia. Almost 70% of ICT products manufactured in Canada are sent abroad. The largest export is wired as well as wireless communications equipment.

Employment has increased steadily in the last ten years, despite the downturn. The number of employed has increased from 440 000 in 1997 to 590 000 in 2005, corresponding to a 3.6% annual average growth rate. In 2006, the number of employees surpassed the level

reported at the peak in 2001. Most of the growth has occurred in software and computer services industries. By contrast, employment in manufacturing industries is declining and since 2000 has declined by 24%. About 230 000 are directly employed by the ICT sector in Ontario.

There is a clear shift from manufacturing to services. The change is emphasised by decreasing revenues and employment. The ICT services sector is growing faster than manufacturing industries, in terms of output, exports and employment. Due to increased global competition and falling prices, profit margins will come under increased pressure, and shifts of technologies to new networks (VoIP) will make competition more intense between large telecom companies, wireless service providers and cable operators.

The sector is R&D-intensive and expenditures account for 40% of private R&D investment in ICT. The majority is spent on manufacturing sub-sectors such as telecommunication equipment.

The province of Ontario has dynamic clusters of innovative ICT companies in a mix of home-grown global companies and foreign multinational corporations. The companies represent a broad spectrum of competence from cutting-edge technologies, such as wireless broadband and photonics to technologies such as telecom equipment, digital media, microelectronics and software.

The historical background of the local high-tech industry in Ottawa can be traced to World War II when there was increased research activity, especially in the field of radio communications. Ottawa became host to several government research laboratories, of which the most prominent were the National Research Centre (NRC) and the Defence Research Telecommunications Establishment, which later became the Communications Research Centre (CRC). Both the CRC and the NRC are still very much present in Ottawa and are participating in several clustering activities. After the war, these research centres provided Ottawa with a high-tech reputation, attracted a skilled work force and facilitated several spin-offs. The first company – Computing Devices – was established in order to exploit technology developed by the NRC for aircraft navigation systems and can be considered a very early "Ottawan" example of technology transfer between the research laboratories and industry, something that since has become a typical strategy for the ICT sector in Ottawa and ensures that Ottawa remains a centre for innovation. Ottawa today is the home of the largest concentration of research scientists and engineers in Canada.

In the 1960s, Ottawa saw the birth of two champions to be: Digital Equipment of Canada and the Bell-Northern Research Laboratory, which became Nortel Industries. In the early 1980s, the high-tech sector in Ottawa had grown to several hundred companies of which a majority were spin-offs from academic, municipal or governmental organisations, but the largest single root was Nortel laboratories.

In the last 20 years, Ottawa has gone through a radical transformation from a government town to a high-tech city, more and more based on cluster development. The city and its citizens have also been confronted with significant challenges. In the mid-1990s, about 15 000 employees lost their jobs when the federal government had to cut expenses. The specific circumstances generated a class of entrepreneurs prepared to create their own businesses.

During the downturn in the early 2000s, thousands lost their jobs, particularly telecom employees. Ottawa managed very soon to come out of the crisis with remaining growth potential. In fact, some ICT sub-sectors grew despite the downturn. In 2006, about

1 800 companies in high-tech industries employed approximately 80 000 people. There are about 70 multinational corporations in Ottawa and the largest foreign company is Alcatel with 1 900 employed locally. The home-grown champion Nortel employs 6 000 people in Ottawa.

The ICT sector in Ottawa consists of several sub-sectors of which the largest are Software, Telecommunications and Microelectronics and wireless. Other sectors are Photonics, E-business and Professional (Technological) Services. Each sub-sector is organised in a cluster. Three clusters have their own co-ordinating and facilitating bodies: the Ottawa Wireless Cluster (OWC), the Ottawa Software Cluster (OSC) and the Ottawa Photonics Cluster (OPC), funded by their member companies.

The strengths of ICT are primarily in software and wireless applications. Businesses within telecommunication equipment are stable, but at a lower level than before the downturn. Photonics suffered greatly from the crisis, mainly due to the telecom sector representing 75% of its market. Government administration is a profitable key market for approximately 900 ICT-related professional service companies. A consolidation within the ICT industries, primarily amongst the service sector through acquisitions and mergers, is emerging and initiated by foreign corporations as well as indigenous companies.

Since the early 1950s, the industrial system in Ottawa has gone through four or five technological cycles. The cluster environment is assessed to be mature, particular within ICT. There are five[4] ICT-related clusters: microelectronics, photonics, professional services, software development and telecommunications equipment.

In general, the growth rate of the clusters has been higher compared to other similar clusters in North America. The key competitors are in Texas, North Carolina and California.

Regional governance and strategies

The mandate over regional development policies is divided over three levels: federal, provincial and municipal governments, for instance, regional municipalities or amalgamated regional municipalities, such as the city of Ottawa.

Responsibility is shared between the governments and more or less independent agencies or not-for-profit organisations. The three federal agencies are more focused on rural areas[5] than on metropolitan areas. Regarding regional programming, the federal and provincial levels are sometimes collaborating, sometimes working in parallel. In theory, the vertical collaboration is weak, but in practice it depends very much on the actual problem to be solved.

On the municipal level, regional development planning is formally carried out under the provinces' supervision. In practice, regional municipalities or cities like Ottawa are rather free and have their own development offices or independent development agencies.

For other relevant development policy areas, the federal government takes more general initiatives, such as R&D programmes, innovation strategies, tax credit programmes or incentives for foreign investments. The federal organisation, the National Research Council (NRC), has offices in each province in order to promote and facilitate R&D and R&D-based economic development on a country-wide basis.

Since the province has a high degree of sovereignty in relation to the federal government, the regional government is allowed to make its own decisions about

launching R&D funding, commercialisation strategies or tax reduction programmes. These initiatives target institutions and companies solely within the province.

The City Council and the Economic Development Office are responsible for Ottawa's policy initiatives and for the planning process. Depending on the service or programme, the city of Ottawa partners with many external organisations such as OCRI, OTCA and OLSC (now part of OCRI). In that way, economic development services can be carried out by both the municipality and an independent development agency, which could be attractive since private industry sometimes would rather work in conjunction with a private corporation than with government, even though OCRI is partly financed by the city of Ottawa.

Economic development activities are guided by Ottawa Vision 20/20 and the City Corporate Plan. Ottawa Vision 20/20 was a response to the challenges of sustainable growth within the newly amalgamated city of Ottawa. It is a long-term strategy for positioning Ottawa for innovation, competitiveness and prosperity and it lays out policies for key Ottawa business markets, including the export sector, the local market and the rural sector. The vision is also supported by a broadband plan to extend broadband connectivity to unserviced areas and to integrate telecommunications strategy into the city's planning and development and a talent plan for improving the workforce infrastructure and link employers to a skilled workforce.

The planning process was initiated and carried out by the city of Ottawa and its Economic Development Office in broad dialogue with business representatives, the research community, public sector representatives, not-for-profit organisations and intermediaries. Therefore, the policies, strategies and actions were well-anchored within partnerships as well as in the broader context of the society. The new Mayor of the city has launched a Transition exercise within the city government to update municipal management practices. It is also the intent of City Council to update the 20/20 vision.

The City Corporate Plan describes how the city proposes to realise its vision and outlines priority areas of focus for city services and programmes. The agendas and actions contained in the City Corporate Plan are the framework for more detailed departmental business plans.

The Ottawa 20/20 growth-management strategy employs a broad approach with inter-related plans covering art and culture, environment, human services, land use and economic development. The vision is expressed as:

> "*In 2020, Ottawa will be a prosperous, entrepreneurial and globally competitive city fuelled by an agile economy that is expert in managing change and reflects the values of innovation, equity and environmental stewardship.*"

The directions to strengthen clusters and entrepreneurship address: 1) strategic support to ensure the collaborative capacity of the clusters; and 2) improving the involvement of local businesses. But there is no sector-specific regional policy. However, OCRI plays an important role in supporting the ICT sector in Ottawa. OCRI is a private not-for-profit corporation that has been the leading agency for regional economic development in Ottawa for the last 20 years. It is based on partnership with 625 members ranging from large corporations, small and medium-sized technology companies, research laboratories, post-secondary academic institutions, regional government, school boards, businesses that service the technology industry, and private individuals. It is funded by several actors: municipal, federal and provincial government grants, membership fees, professional development programmes and private sector contributions. The structure of the

membership is a guarantee that initiatives and decisions are well-prepared and anchored to the cluster context as well as to high-level decision makers in Ottawa.

OCRI's mission is to bring people, ideas, and resources together through partnerships, policies and programmes. Some of their key service areas involve: international outreach/ marketing, educational support, networking, cluster support, business development and advocacy with technology and innovation as the core. OCRI supports the ICT clusters through a range of activities in order for the sector to maintain its identity and flexibility while maximising the effectiveness of volunteers and minimising demands for funding. The support activities are of two types: logistical and strategic. Logistical support covers activities such as membership management, financial management, website development, hosting and maintenance, member communications and event management. Strategic support and political know-how are provided through several different organisations within OCRI. For example, the Entrepreneurship Centre which supports local entrepreneurs and small businesses with training and consultations and OCRI Global Marketing which provides service activities for marketing. Ottawa has been marketed as a Global Technology Centre in order to attract investment and talent and explore trade opportunities. Another example is OCRI TalentWorks which addresses workforce issues with a "one table and one voice for workforce initiatives".

Another important player is The Ottawa Partnership (TOP) as a strategic advisor to the city of Ottawa. The partnership is sponsored by the Economic Development Office and has a broad representation of competence within the private as well as the public sector, mainly high-level leaders. The main objectives of the partnership are to: 1) identify relevant goals and strategies; 2) monitor the economic foundations and suggest relevant solutions; 3) improve collaboration between governments, economic agencies and industries; and 4) promote key export-based growth clusters as well as emerging "seed" clusters. Around this core of public and private-public players, there are provincial and federal supporting structures providing strategic initiatives and funding, as well as high-level expertise.

The ICT clusters are also provided with strong academic and R&D support, such as Canada Institute for Scientific and Technical Information (CISTI), the Communication Research Centre (CRC) and the National Research Council (NRC). Moreover, there are eight colleges, universities and business schools. Ottawa has the highest concentration of engineers and PhDs in Canada.

General conclusion

Ottawa was a pioneer in adopting the cluster model to meet the challenges of the new knowledge-based economy. In 1999, The Ottawa Partnership (TOP) took an important step on the cluster scene when it initiated the Economic Generators project. The partnership managed to draw attention to the importance of cluster-based development as a tool in the new economic context. Of 33 specific initiatives focused on the seven clusters in the TOP report, ten have achieved tangible results. The project could be seen as the most significant cluster initiative and strategic input to Ottawa 20/20.

Before addressing challenges, strategic directions and policies for Ottawa 20/20, the clusters' life-cycle status and performance were assessed. Two clusters were in the expansion phase: telecommunications equipment and microelectronics/semiconductors, while two were in a transformation phase: software and communication, as well as

professional services. The strategic directions varied depending on maturity and external threats: the telecom industry had to protect innovation capacity and to strengthen diversification while professional services had to focus on consolidation and export services.

TOP and OCRI have had key roles in strategic development and in facilitating the business climate in general as well as more cluster-specific actions. Obvious advantages are the strength of local collaboration and the high degree of social capital. Compared to Ottawa's industry, the clusters' growth rate is three to four times higher than the average rate. Furthermore, the clusters rated very well in a benchmarking procedure against other comparable clusters in North America. An important strength is the technological sophistication. Several clusters are operating near the highest level of the value chain.

The cluster approach is not only to be applied to the ICT sector but to different sectors. It is believed among the stakeholders that competitive clusters evolve due to supporting infrastructure which allows the clusters to focus on their main activities, an approach appreciated by the private sector. Company representatives said that in comparison with many other agencies OCRI provided good services with the right skills, and by disseminating what is going on in the region and bringing people together, OCRI contributed to the development of the ICT sector. For example, the marketing and promotional efforts of Ottawa as a high-tech region with an increased level of investment as a result. Another example is the improved relationship between firms and the university; activities carried out within the university are now more adapted to business needs with assistance from OCRI. Company representatives also urged that public policy should sponsor more activities through OCRI.

Despite its successful development, the city of Ottawa is facing several challenges and problems. The weaknesses of Ottawa could be summarised as:

1. Financing: lack of early stage investors as well as declining venture capital investment. The number of venture capitalists with a local presence has remained stable, but the investment has dropped.
2. Business climate: need for more attention from government.
3. Infrastructure: lack of flexibility on community level so that suitable available space can be limited, land and transportation facilities, such as direct flights to Europe and northern California. Silicon Valley is the largest business partner and the largest source of foreign venture capital.
4. Staying power: capability to respond to technological or structural changes.

Many companies are expanding in other regions, mainly due to lack of appropriate venture capital. Entrepreneurs in Ottawa are underfinanced compared to competitors in other cities or in the United States. However, opinions regarding financing are diverse: some complain of the lack of seed capital as well as venture capital, while some identify inadequate funding in later growth stages as a weakness.

There is a need for more large and innovative companies, like Nortel, as complementary locomotives in clusters. More anchor enterprises are also demanded. Moreover, current company structure makes the business environment vulnerable to change and external threats, such as market shocks and the impact of technology cycles. More medium-sized companies are needed to constitute more robust clusters and to improve the growth potential.

The city of Ottawa is aware of future threats such as the ongoing restructuring of the manufacturing industry. The labour market is vulnerable due to lack of diverse employment opportunities. Another question is the challenges of downsizing, outsourcing and offshoring.

In addition, many multinational companies are not doing business with sub-contractors within the clusters. A challenge (also pointed out in the Ottawa 20/20 report) is to improve the integration of local small businesses in the growth context, creating more values and wealth in the extended city of Ottawa. Perhaps, public procurement could be used as a driver of the local economy and strengthen the link between fast-growing cluster companies and the local business environment.

Most regional economy is seeking to accelerate the innovation process. Ottawa's universities and national laboratories still have weaknesses in entrepreneurial spirit and the spin-off culture of high-tech-related inventions. There exists a strong Angel Network in Ottawa that is keeping early stage funding alive but institutional early stage funding vehicles in Canada and Ontario is lacking and there is a decline in venture funding. This is partly due to the downturn when a lot of money disappeared.

The collaboration between universities and companies is rather weak, though it is improving. TOP has recently released a concept on an innovation hub and the Ontario government has launched a series of initiatives aimed at commercialisation, both related to universities and corporate R&D. The transfer of research-based knowledge to businesses is primarily a role of the research institutes, certain centres or transfer offices, such as the Strategic Microelectronics Consortium (SMC) and the Canadian Photonics Fabrication Centre (CPFC).

In general, there are demands for a coherent commercialisation strategy as well as improvement of the infrastructure. To increase the capture of R&D expenditures and accelerate the innovation process requires not necessarily more funding, but perhaps new ways of using existing resources instead. The strategic directions and policies (in Ottawa 20/20) of the innovation process and new methods for accelerating the speed of inventions from discovery to the market are to be further strengthened. Moreover, questions have been raised about a shift of ICT policy from a sector approach to a broader perspective of technology as an enabler of economic development.

Recife, Brazil

Introduction and basic data about the region

Recife is the capital of the state of Pernambuco, in the north-eastern part of Brazil, and one of 27 states. The North-east is one of the poorest regions in the country. In 1999, the GDP per capita was about 46% compared to Brazil as a whole. The gap between the north-east states and the richest in the south has not changed during the last four decades. On a ranking list the North-east has a lower position than 40 years ago. Between 1970 and 1995, Pernambuco had the lowest annual growth rate among all states in the North-east.

Greater Recife[6] includes 14 municipalities and the metropolitan area has about 3.1 million inhabitants, out of approximately 8 million in the state of Pernambuco. Recife is the largest metropolitan area in the North-east and the third-largest in Brazil. Moreover,

the city accounts for about 75% of the GNP of Pernambuco where the working population is estimated at 3.8 million and the rate of unemployment is approximately 6% (1999).

The economy of Pernambuco has for a long time been based on gypsum production, the sugar cane industry, the clothing industry, wine production and its international harbour. The state accounts for 90% of the gypsum reserves in Brazil and represents one of the biggest sources on the American continent. Pernambuco is also the second-largest producer of cloth and wine (Marinho, 2005). In the 1990s, the state has experienced a fast-growing modern services sector, primarily in medical technology and software.

The ICT sector's share of GDP is 1.8% in Pernambuco compared to the national average of 0.8%.

The Brazilian states enjoy a significant autonomy of government, law making, public security and taxation. The states are divided into municipalities which have their own legislative council and mayor. The municipalities could also be divided in towns but they have no separate government.

The ICT sector in Recife

In the 2000s, Brazil is a centre of the ICT industry and a leading market in Latin America. The expanding market has lured many foreign information services and software companies to establish local subsidiaries in Brazil. Furthermore, national firms also managed to benefit from the growth and to find profitable niches, for instance within banking. As a whole, in 2001, the turnover of the largest enterprises (372) was estimated at approximately USD 11 billion, of which hardware accounts for 50%, services for 35% and software 15% (see *www.mait.com*).

Brazil has four major ICT clusters, but each with a different business focus: Porto Alegre (software to medical care), Recife (software), Rio de Janeiro (telecommunications) and Sao Paulo (wireless). The federal government's policy of protecting ICT had its major impact in more industrialised areas, such as Rio de Janeiro and Sao Paolo, but it also promoted businesses in less developed regions.

The history of the ICT sector in Recife dates back to the beginning of the 1980s. In 1982, a close collaboration in development of ICT-based financial services began between the university, local software companies and the northeast region's major bank, Banco do Nordeste. Consistent with government policy, the collaboration laid the foundation of an emerging local ICT market in Pernambuco where the bank not only was a qualified and demanding procurer, but also an important recruiter of university-trained ICT professionals.

The positive outcome of the collaboration encouraged the team of professors at the university to set a new objective: *the Department of Information and Communication Technologies should be one of the top academic institutions within ICT*. However, due to the financial crisis in the mid-1990s, the successful collaboration was interrupted; nonetheless, the academic team had managed to achieve a good reputation and to market the university as a top institution, not only in Brazil, but also in Latin America.

In the early 1990s, several doctoral students went to the United States to complete their PhDs. When they came back to the university, they started the Centre of Informatics. However, many students did not stay in Pernambuco after graduation. They moved to the South to get better job opportunities and better pay. This leakage of skills represents a great challenge to Recife and to the state and a threat to the development of the region.

In 2000, the state government launched the cluster initiative Porto Digital to further develop the ICT sector and facilities were built up in the old harbour and dockland area. Since then, Recife has step by step improved its brand as a growth pole and as an innovative place to run a business. Successful marketing has given confidence to clients as well as proven the advantages of moving to the city and to Porto Digital.

In 2001, Recife had about 250 start-up firms within a broad business range from cell phone technologies to computer games. Approximately 600 local ICT companies generated profits corresponding to USD 72 million, expected to be tripled or quadrupled in a few years. Recife has a strong reputation within academic areas such as medicine and technology, and the second hospital cluster has its base in the city.

One hundred and eighty collaborators are involved in the Porto Digital initiative and they are involved with large foreign corporations such as IBM, Motorola and Nokia. Small and medium-sized firms are dominating the cluster's company structure. Only two or three are larger enterprises. In total, there are about 100 companies in Porto Digital employing approximately 300 people and the average age of the employees is 35 years. Almost 50% of companies have moved from elsewhere within the metropolitan area to the cluster.

Businesses involved in ICT applications in Porto Digital range from computer games, financial services, healthcare systems, logistics in mining and railway and road traffic informatics to software development in general. Almost 50% of sector output in Recife is sold outside Pernambuco, mainly to the southern part of the country.

Approximately 75% of the revenues within the telecommunications sector in Brazil are generated by services, while the remaining part is that of software and equipment. The software industry is growing fast, about 25% a year, and approximately 10 000 companies employ 200 000 people.

Regional governance and strategies

In the early 1980s, the objective of the Brazilian government policy was to build up and strengthen the domestic ICT sector and its internal market, mainly through restrictions on foreign investments, imports and technology transfer. An overall goal was to achieve a more diversified and robust industrial base. Moreover, the policy action should also encourage indigenous companies to spend more money on research and product development.

Ten years later, the policy arena was characterised by liberalisation, deregulation and privatisation. The country opened up to foreign investments and technology transfer. The deregulation and privatisation increased competition, price levels declined and the computer industry grew. In 1999, the federal government launched an "Information Society Programme"; the aim was at least threefold, addressing improved accessibility to ICT in general, strengthened business competitiveness and more efficient public services (e-government). According to the programme, efforts should be made by public-private partnerships to eliminate barriers, such the high cost of personal computers, in order to increase ICT usage among low-income citizens.

One of the first important players involved in regional development policies in the North-east was Northeast Bank,[7] established in 1952 and from the beginning a development bank. In the late 1950s, the federal government founded a regional development agency, Sudene,[8] which became an important player in the regional development policy arena. The

main objective of regional policies was to spend resources on decreasing the gap between the richest and the poorest states in the country.

In the last decades, step by step, regional development policy has lost its significance on the political agenda and the instruments have been dismantled. Moreover, in 2001, the federal government decided to replace Sudene with a new agency (Adene), but the new agency did not attract adequate resources to remain in operation. The lack of federal government regional policies triggered a fiscal war and an unhealthy competition between states as well as municipalities.

A re-orientation of regional policy development occurred in 1997, when the Pro-Northeast Initiative was launched by three state governments (Bahia, Ceará and Pernambuco) with support from the World Bank, a national bank and a research institute. The initiative had a new strategic approach focused on industry cluster policy addressing four sectors in three states: fruits, grains, informatics and tourism. The overall objective of the policy was to accelerate growth, increase prosperity and to reduce the gap between the north-east and the south.

Another initiative, the Development Lighthouse, taken by Northeast Bank, had a broader and more general perspective and the project rejected the cluster approach. The initiative concerned all municipalities in the North-east and the strategy was to contribute to improvements of local producers' competence and competitiveness. Under leadership of the local bank's staff, partnerships between municipal authorities, trade unions, employers associations, public enterprises, religious leaders and NGOs were involved in the process and implementation of the initiative.

When the new government[9] took over in 2002, it promised to upgrade regional policy issues and to establish a national authority as well as a national fund for regional development.

As a successor and complement to the Pro-Northeast Initiative, in 2004, the city of Recife decided to carry out a Metropolitan Region Development Strategy focused on improved collaboration between public, private and not-for-profit organisations in order to promote economic growth, increased prosperity and equity. The challenge was to integrate urban renewal with the valuable heritage of the old city, while providing excellent infrastructure and opportunities for the future digital economy.

Regional development policy initiatives such as the Pro-Northeast Initiative and Development Lighthouse were not addressing a single sector. When public enterprises were privatised in the 1990s, some of the revenues were collected in specific funds available for sector development funding.

In 2000, the Pernambuco government decided to support the ICT industry by establishing an innovative system (cluster) called Porto Digital. It could be seen as an economic development project whose purpose was to foster an industrial structure for interaction between local industry, university and government, thus providing technological expertise in the field of software development for offshore outsourcing and ICT services. A major aim is also to promote emerging firms, entice companies to move to Porto Digital and attract federal financial support.

BRL 33 million was initially invested (approximately USD 13.2 million) by the state government but funding has also been provided by government bodies such as Facepe (Foundation for the Support of Science and Technology in Pernambuco), AD-

Diper (Pernambuco Development Agency) and Sectma (State Government Department of Science, Technology and the Environment).

The cluster is managed by Porto Digital Management Unit (NGPD) a not-for-profit civil association, defined as a Social Organization (OS) under Brazilian law. They have been entrusted both regulative and financial authority in order to further promote innovation and establish new start-ups. Since the administrative burden is high in Brazil and public organisations have to follow several bureaucratic steps, the government has created a social organisation law which allows them to delegate activities they consider do not need to be carried out by the state to so-called social organisations. This is done by a contract between the organisation and the state level. For example, the government can delegate the power to manage a hospital but decisions have to be backed by law and the government has always 40% of the board seats. The constitution of the Porto Digital Management Unit Board is as follows: 37% government representatives, 21% from the production sector, 11% from universities, 16% from non-governmental organisations, and 16% from other groups of society. They control development by setting objectives, goals and guidelines for the operation.

The Porto Digital initiative is a kind of regional strategy where the State delegates public policy to a social organisation. A parallel policy would not work since strategy is still the prerogative of Porto Digital. Pernambuco need more initiatives like Porto Digital in other sectors.

The state of Pernambuco's decision to promote the telecommunications industry was part of an overall regional development policy including infrastructure improvements such as a new airport, broadband, energy supply, railways, schools and restoration of the old building environment. The state government also provided growth promotion to the region as a whole, for instance technology centres, incubators, entrepreneurs, design support to innovators and branding. The choice of what to support was primarily due to political considerations which viewed a strong and competitive ICT industry as more or less a prerequisite for growth within other business sectors.

From the beginning, the emergence of the ICT cluster was not the result of a strategy, but as a result of group engagement and the joint efforts of driven individuals. The embryo of Porto Digital was a team of software engineers working as consultants in addition to their lectureships at the university. Much *informal energy* comes from the university and the cluster would likely not exist without the initiatives taken by the university and spin-offs from the academic environment. In the beginning, the business environment was rather weak and firm creation was mostly spin-offs from academia.

During the first two years, NGDP focused on structuring tools, laws and incentives in order to attract and enable companies to set up offices in Porto Digital. Historical buildings were renovated and Human Capital, with a focus on vocational training, and Risk Capital Investment Funds (FCH and FCR, respectively) and the Guaranty Fund were put into place, offering guarantees of up to 70% for loans by public banks to software companies. Municipal Act 16.731/01 also benefits companies through financial incentives allowing for a reduction of up to 60% of the local sales tax on services (ISS).

Today, NGPD focuses on developing the business environment through technical co-operation agreements and technology transfer, encouraging integration between stakeholders in the State of Pernambuco; infrastructure projects and marketing Porto Digital nationally and internationally are also one of their main activities.

More specifically, the activities involve venture capital funding: for no-interest funding and human resources funding. The strategy for urban development is to provide companies within Porto Digital with modern ICT infrastructure and the NGDP has ensured the roll-out of 26 km of optic fibre on the island of Recife, which is the geographic location of Porto Digital. It has also been instrumental in the renovation of several historical buildings now used by companies established in the cluster. Porto Digital also provides funding to new firms setting up innovative businesses or assists such companies with applying for funding to governmental agencies or to private capital, something which is considered equally important. Human resources funding is not just an instrument to enhance the educational level in the region but to provide the growing business community with human resources and skilled employees. Porto Digital therefore is also actively financing programmes for professional training (support technicians) and digital literacy training. It provides seminars to the general public and free internet access as well as a library. Thus NGDP enhances both conditions for the business sector and social cohesion while creating a growing reputation for Porto Digital nationally and internationally.

Porto Digital has two incubators, CESAR[10] and Apolo Support Integration Center. So far, CESAR has fostered many spin-off firms; the other incubator is organised as a micro-innovation system hosting not only start-ups, but also established and growing companies. As promoters of technology transfer and export, there are not-for-profit organisations targeting certain sub-sectors, for instance, software development.

An interesting initiative taken by Porto Digital concerns social inclusion. Low-wage earners or unemployed people living in shanty towns on the periphery of the cluster are offered training in computer programming. After the courses, some of them were offered employment by companies in Porto Digital. Moreover, the city has also promised to improve the standard of housing. It can perhaps be seen as an example of how important quality of life issues are perceived by policy makers in cluster approaches.

General conclusion

Apparently, the cluster policy approach has been central in developing the ICT sector in the state of Pernambuco and Recife and appreciated by the private sector. For instance, entrepreneurs in software businesses claimed that the Pro-Northeast Initiative provided them with profitable commercial links with the US market, but there are few concrete results. However, so far it is quite clear that "*the idea of clustering as the basic component of a regional development strategy has become established*".

Porto Digital is seen as a far-seeing and proactive initiative to be further applied in other sectors. It was launched to promote the cluster embryo already in place in the mid-1990s. The policy has worked as a tool for mobilisation and allocation of resources to an emerging cluster. It also implies that the cluster approach is recognised by governments and universities, as well as the business community, and the initiative was backed by all actors in Recife. It has encouraged the relationship between the university and industry and knowledge spillovers in general.

The cluster approach has had a great impact on marketing and branding. Porto Digital has attracted domestic as well as foreign investors and the city has gone through a technology makeover in order to become a kind of Brazilian Silicon Valley, luring new start-up firms as well as national and foreign corporations. Ericsson, Microsoft and Motorola

have already made investments in Recife, but a national champion and/or anchor firms are still lacking. Such locomotives are seen as necessary to foster cluster growth. Since the cluster is recognised by the state, membership in Porto Digital generates confidence among entrepreneurs and companies as well as within the public sector. Moreover, the policy has further strengthened the collaboration between Porto Digital and the university. The policy has also promoted a financial infrastructure with a supply of business angels, pre-seed capital and venture capital funds.

NGDP has carried out extensive infrastructure improvements, such as in the area of housing and real estate; however, the public sector's involvement is questioned among the stakeholders since it competes with private companies.

Some argue that Porto Digital has grown too fast to be able to meet the needs of the companies. There were claims for lower taxation on profits as well on labour, simplification of labour laws and less administrative burden on companies. Moreover, companies are asking for better and more open public procurement routines. Today, small firms have almost no chance to compete for public calls for tender, if they get any information at all. The main government tasks should be to promote collaboration between companies, exchange of ideas, and to provide financing and marketing support.

The business atmosphere is still somewhat individualistic and collective actions within the cluster are rather rare. Lack of collaboration between companies and lack of venture capital are still issues. Therefore, an initiative on company collaboration is necessary. The policy has also underlined the need for more appropriate financial infrastructure to accelerate the commercialisation of invention and business ideas.

There is a demand for an updated and more long-term cluster strategy for the next 10 to 15 years to indicate a sustainable commitment to Porto Digital in the eyes of stakeholders and external potential investors or promoters. From a regional perspective, there is also a need for a comprehensive regional development strategy.

Lack of large and manufacturing companies is a key problem within many clusters, but the major challenge for Porto Digital is to be able to meet the fast-growing cluster's increasing demands, for instance, for skilled people or financing.

The education sector, primarily the secondary level, needs improvement. Skills in foreign languages, mainly English, are very poor, but among younger people working with computer programmes produced in the United States the situation is somewhat better. Too few (10% of an age group) choose to continue on to university level. There is an imbalance between the graduates' competence profile and companies' needs; about 50% are graduated in law. Arguments were also raised regarding a more long-term perspective on education and better funding facilities.

Many of the weaknesses, mentioned above, were directed at the state and federal level. The three major problems seem to be the education system, research and development facilities and researchers adverse to work in the industry. Lack of skilled people can be expected, partly due to graduates moving to the South to better jobs and better pay, and partly due the growth of the cluster.

By virtue of the policy, the government has successfully promoted the redevelopment of the Old Recife Quarter as a site of the digital economy and the creation of Porto Digital. However, Recife is the only technology cluster in the north-east part of Brazil, which could also be one reason for its quick success.

The regions may need to develop a long-term strategy (a time horizon of 15-20 years) focused on: 1) language skills (English); 2) collaboration between companies; 3) foreign investment (more large companies); and 4) financial infrastructure.

Stockholm/Kista, Sweden

Introduction and basic data about the region

Stockholm is the capital of Sweden, located on the east coast of Sweden. The city of Stockholm is part of the much larger Stockholm county. Together with four other counties, Uppsala, Södermanland, Västmanland and Örebro, Stockholm county forms the Mälardalen region, which is of principal importance to Sweden as its major economic engine. The region produced 39 % of the GDP in 2002 and its growth is significantly higher than for the country as a whole. However, there are several ways of delimiting the region and for the purpose of this study, data refers to the three counties of Uppsala, Stockholm and Södermanland. These data also correspond relatively well with a functional definition of the Stockholm region.

Stockholm county is, from a growth perspective, the strongest region in Sweden. Between 1995 and 2004 the average regional annual growth (GRP) was 5.5 %. The accumulated growth for the same period was 63% compared to 44% on the national level. The rate for the openly unemployed in the county of Stockholm was 4.2% at the end of 2005, compared to 5.6% for the whole country.

Several of Sweden's largest and most well-known universities, such as the Karolinska Institute (KI), Stockholm University, the Royal Institute of technology (KTH), Uppsala University and the Swedish University of Agricultural Sciences are situated in the Stockholm-Mälar region.

The region hosts a number of strong "clusters" in several sectors such as ICT, biopharma, financial services and logistics. These are dominated by a few firms, for example Ericsson, Nokia and IBM in ICT, AstraZeneca, GE Healthcare and Pfizer in biopharma.

Formally, the County Administrative Board is the principal regional governing body representing the national government. Swedish municipalities are autonomous in relation to the national level and have their own elections every fourth year. The county is responsible for regional economic development while local government provides public services and supports local economic growth. Another separately elected administrative body, the County Council, is responsible for healthcare, public transport and regional planning. Due to the allocation of public resources, the city of Stockholm is the most influential governing body in the County.

The ICT sector in Stockholm/Kista

The Swedish telecom sector has undergone a radical change during the last 10-15 years through de-regulation of the telecommunication market as well as the disintegration of the alliances between state-owned monopoly enterprises (Televerket) and companies manufacturing equipment for the telecom infrastructure (Ericsson). This has offered great advantages to companies such as Ericsson as a springboard for growth and success. During most of the 1990s, the ICT sector had an even and rapid growth with regard to markets, profits, number of employees as well as new emerging businesses.

After years of growth, a big downturn occurred in March 2000. The telecom sector was hit very seriously, including Ericsson – which was later very close to bankruptcy. At the end of 2002, Ericsson was forced to dismiss about 40 000 highly qualified employees. Moreover, in a "domino effect", the crisis was diffused to the supplier chain. In order to survive, many companies were forced to downsize their businesses.

There are approximately 15 000 ICT-companies (IPTS, 2006) employing 185 000 people in Sweden today. Six thousand of these companies are situated in the county of Stockholm, employing about 70 000 people (see *www.stockholmbusinessregion.se*) and around 7% of the workforce. The sector can be categorised in two main categories: the electronics industry and ICT-related services; *e.g.*, telecommunications, consultants, retail and trade, with a continuing transformation from manufacturing of, for instance, electronic components and systems, towards producing ICT-related services. Today, 14 000 ICT companies are service companies and the sector employs about 138 000 people in comparison to 50 000 employees within the electronics industry. The electronics industry is dominated by a small number of large companies that are still suffering from the downturn in the early years of this century.

The ICT sector in Stockholm is concentrated in Kista, a municipality within Stockholm county. This has not always been the case. Before 1970 most ICT companies had their headquarters in the southern part of Stockholm, but Ericsson needed more industrial space and, attracted by inexpensive land, they established Ericsson Radio Systems in Kista. Other companies then followed suit, for example, Adobe, ABB, HP, Intel, Nokia, Oracle and Sun – also because of cheap office space as well as good transport facilities and a good supply of qualified labour, among others.

Kista suffered greatly from the ICT downturn in 2000, but after redundancies of thousands of highly qualified engineers and restructuring from manufacturing to systems, software and services engineering, the recovery of the cluster has been successful. In 2006, the level of employment was even higher than before the bubble burst.

Today, Kista has more than 500 ICT firms (Kista, 2006) and approximately 19 000 ICT employees. Four hundred new ICT firms moved in during the last three years. In addition, there are 4 000 students and 800 researchers. Kista has four research institutes, mainly focused on applied research.

Most of the firms are small or large-sized firms with the small and medium-sized knitted to the value chain of large firms. Most of the supplier firms are low value added. There is a need of more medium-sized companies in order to make the cluster less vulnerable. A larger body of manufacturing companies is also sought.

Regional governance and strategies

The general business climate is important for cluster growth and development. These comprehensive conditions are to a great extent decided on the national level, for instance, tax policies and market regulation policies, but also issues such as investments in large infrastructure projects: motorways, railways or airports. Other policy areas on a national level relevant and important to clusters are of course industrial and regional policies.

Even more relevant for cluster development are national policies on education, research and development as well as innovation systems. In general, money is distributed via national programmes [11] and tender procedures in open competition.

Comprehensive regional planning of the facilities for economic development is the responsibility of the County Council and its expertise at the Office of Regional Planning and Urban Transportation. There is no single, unified economic development strategy for the entire Stockholm region. The fact that the region consists of several administrative units reflecting neither the Stockholm labour market area, covering two counties, nor the expanded Stockholm-Mälar region, covering five counties, leaves the governance structure somewhat complicated and fragmented and not well-adapted to the tasks and challenges it faces. The administrative borders do not match the functional borders with respect to, *e.g.*, labour markets and commuting, and the regional level does not have the authority to work with these issues since it lies within the local municipalities' jurisdiction, which also have both the resources and capacity necessary.

The County Administrative Board put together the Regional Growth Programmes (RTP) and the Regional Development Programmes (RUP) which aim broadly to sustain regional growth and better co-ordinate efforts of local actors, through collaboration for the development of overall strategic plans. However, these plans and programmes could not be described as comprehensive economic development strategies, since the resources and ability to deliver the strategies rest with municipalities. Furthermore, the programmes are regarded as platforms for common understanding with no directed financial means allocated.

There is no explicit regional strategy for the ICT industry and no specific instruments for sector development. ICT is one of several growth sectors within the Regional Development Plan, but it is not one of the prioritised sectors within the Regional Growth Programme. The reason for this is that the sectors are picked based on their own interest in participating and cluster facilitators in Kista considered that they had not yet found a productive form of collaboration. Instead they often use direct channels to the national as well as the municipal actors. The County Administrative Board also assessed the cluster as being strong and mature and opted to focus limited resources on five other cluster platforms: biomedicine, biotechnology, creative industry, healthcare and environmental technologies. In 2003, after the downturn, the Country Board was involved in preparation of several projects on restructuring of the sector, but nothing was implemented. The cluster, local and regional levels didn't attain a joint approach that met the challenge of downsizing and redundancy of hundreds of civil engineers. Instead, there was a market-driven transformation from manufacturing to systems and services-building and engineering.

The ICT cluster in Kista has developed without a policy targeted to the ICT sector. However, three different public policy actions have played a role in developing the ICT cluster in Kista. The first important policy action was the municipal and regional initiative and decision to develop an ABC-city[12] on the former military training campus in Kista in the 1970s. The second important policy action was the national programme on micro-electronics in 1983 and the city of Stockholm's initiative to establish a centre for micro-electronics, based on experiences from, for instance, Silicon Valley, or corresponding agglomerations in Europe, such as Paris and Grenoble in France, where interaction between industry and academia has proven to be very successful. The third policy action was the renewal of the Electrum Foundation in the year 2000 as a response to a declining interest in staying in Kista among students and companies. The Mayor and the Director for Business Development in the city of Stockholm are on the board of the Foundation as well as representatives from the local business community (*e.g.*, the ICT sector and the real

estate sector) and academia. Electrum designs the strategy for Kista with Kista Science City AB (KSC AB) as the executive arm managing the cluster.

Kista Science City encourages co-operation between state and local governments and private actors, marketing Kista as a fertile site for establishing new businesses and developing and operating interactive networks for professionals in Kista. In 2001, a vision, extending to 2010, was adopted by Kista Science City:

> "*Kista will be known as a world-leader in three areas of growth: Mobile services, wireless systems and broadband systems. A world-leading position in mobile services will be created. The current world-leading position in wireless systems will be maintained and further developed. Stockholm will be viewed as an international nucleus in the development of broadband systems and services for the future.*"

This vision could be understood as a lodestar governing cluster development. The vision includes a step up from a Science Park to a Science City, implying a holistic approach also covering cultural and social issues, such as social cohesion. It could also raise the question, though, as to what extent the vision is anchored in a broader context in Kista. The vision has no governing power, but at least it could be seen as an adaptive, flexible and supportive guideline to meet business needs and challenges of tomorrow.

Under the umbrella of Kista Science City there are five company networks, focused on knowledge exchange, development of technology, supply of labour/competence and lobbying. The networks have shown evidence of success in the field of infrastructure improvements, not least of which in attracting the Swedish Defence Research Agency to move to Kista. Today, the networks are supported by Kista Science City; in the future they are expected to be self-supporting.

Another subsidy of Electrum Foundation is Stockholm Innovation & Growth AB (STING). Their vision is to promote the best entrepreneurs and companies with a potential of growing abroad, since the domestic market in Sweden is very small. Today, about 140 projects are assessed every year and 15 start-ups are fostered, which has tripled in five years. STING has also managed to find seed capital as well as venture capital. Since 2002, about 80 new technology-based companies have been established in Kista, 46 of which are supported by STING. STING has four main programmes: 1) Start Up: a training programme for ICT entrepreneurs; 2) Business Lab: a business pre-incubator for projects during very early phases of development; 3) Business Accelerator: a business incubator for companies during the very early phases of development; and 4) Growth Programme: a programme tailored to individual needs and conditions for established SMEs that require support for international expansion.

Most of the new technology-based companies in Kista are spin-offs from existing companies while spin-offs from the university are not so common. The fostering strategy of new technology-based business ideas was not very productive during the 1990s.

The facilitators are well-anchored among the stakeholders, such as industries, real estate companies, universities and municipal government actors.[13] However, since the budget is very limited, the intermediaries must have a lean organisation working smart to be flexible, adaptable and successful in meeting the challenges.

General conclusion

Kista has been developed as a successful business-driven cluster with Ericsson as an engine for development and with the city of Stockholm as a trustworthy promoter and

facilitator. The change from manufacturing to systems, software and services engineering, a process accelerated as a result of the downturn, has been successful and, today, there are more jobs than before the crisis.

In the beginning, the city had no intention of creating an ICT cluster, but when high-tech companies in electronics moved in, politicians saw the opportunity to promote something very specific. Most people would say that Kista Science City has been successful in marketing the cluster as a hotspot and a useful instrument for bringing actors together and for lobbying through the different networks such as Kista Business Association. Kista Business Association did a lot of lobbying in order to get the Swedish Defence Research Agency (FOI) to come to Kista, as well as for improvements of the infrastructure. In general, the industry's expectations of government actors primarily concern their power to make decisions about infrastructure or about moving public authorities to the area, as well as promoting a favourable climate for entrepreneurship and generic policies rather than sector policies, and public procurement as a driving force for innovation in general, and for small and medium-sized companies in particular. From the perspective of research institutes, a greater commitment by politicians to improvement of the cluster environment was demanded, while industry asked for a national policy fostering co-operation between industry and the university. Another opinion expressed was that regional policy considerations often seem to be more important than the potential for a qualified critical mass.

It could be argued, though, whether or not Kista Science City has worked as a framework for co-operation between government actors on various levels, partly due to the absence of regional authority involvement in Kista. However, on the municipal level the cluster has been an interface between Stockholm city and the four neighbouring municipalities of the cluster, for instance for a dialogue on urban and industrial development.

There are several challenges facing the region, such as, improvement of infrastructure, creating better synergy between companies and universities, and improving public procurement as a driving force for innovation in general, and for small and medium-sized companies in particular.

When Kista was established in the 1970s, there was a very close collaboration between the Royal Institute of Technology (KTH) and the ICT industry. Ericsson was the key partner in interaction with academia, in the field of education as well as R&D. At the end of the 1990s, KTH moved ICT-related activities to Kista because of the industry's demand for closeness to university facilities. After the downturn, Ericsson began downsizing, outsourcing, and restructuring from a manufacturing to a system-builder engineering company. This caused a mismatch between the KTH competence profile of the graduates and the new demands of the industry. Today, the industry does not provide much input to the development of educational curricula. Moreover, companies appear less interested in academic research since they are more focused on product development and have shorter time horizons than the universities. On the other hand, the university remains focused on basic research and has to spend time finding external funding. Moreover, some foreign companies are not interested in locally generated R&D, since they are only sales organisations or have their own internal R&D networks. Despite these recent developments, representatives of both sides are now expressing their desire to improve collaboration between industry and academia.

The number of spin-offs from the university has not been satisfactory, based on the targets set. There are too few entrepreneurs and too little entrepreneurial spirit in the public R&D environment. So, in terms of policy, it might be advisable to develop and implement a national and/or regional programme on economic incentives promoting SMEs' collaboration with R&D institutions, as well as strategic alliances with others companies (using public procurement as an additional driver).

Furthermore, big differences between multinational companies and small and medium-sized firms exist. SMEs have almost no contact with governmental actors or with academia, and they seem to shy away from big institutions such as the university. Most of the company networks have come about to respond to the demands of large companies. Small and medium-sized companies are working more in isolation, partly due to lack of resources, such as time and money, partly as the result of a more general scepticism regarding big institutions, large companies as well as universities.

Finally, according to the vision of a Science City, the lack of social cohesion is a serious problem. Very few of the cluster employees are living in Kista. Most residents in Kista are immigrants and the rate of long-term unemployment is high. This is threatening the environment as the whole, as well as the attractiveness of the cluster.

Notes

1. This chapter is to a great extent built on the "Global Outlook for the ICT Sector – Future Drivers, Trends and Barriers", prepared for OECD International Future Programme by Simon Forge of SCF Associates, Erik Bohlin of Chalmers University and Colin Blackman, Shaping Tomorrow.
2. This has been explored at length, especially for emergency/security networks and for health/elderly care applications in recent EC/JRC/IPTS studies, particularly work package 2 of the study "Mapping European Wireless Trends and Drivers (MEWTAD)", IPTS, August 2005.
3. The old model of closed innovation; successful innovation requires control. Companies must generate their own ideas, then develop, manufacture, market, distribute and service their own ideas. The new model of open innovation; the old model is obsolete in many industries. Today, useful knowledge is widely disseminated and the ideas need to be used alacrity otherwise they are lost. Companies must harness outside ideas to advance their own businesses while leveraging their internal ideas outside their current operations.
4. Two more are mentioned, for instance in *Ottawa 20/20 – Economic Strategy*, namely life science research and tourism.
5. The mandate of FedNor regards primarily the northern part of the province.
6. The Recife Metropolitan Region (RMR).
7. Banco do Nordeste.
8. The Superintendence for the Development of Northeast.
9. The Luiz Inacio Lula da Silva government, the president re-elected in October 2006.
10. CESAR = the Recife Advanced Studies and System Centre.
11. The Swedish Agency for Innovation Systems (VINNOVA) and The Swedish Agency for Business and Regional Development (NUTEK) have been responsible for innovation systems programmes and cluster programmes, respectively.
12. A = workplaces, B = housing and C = commercial and public services.
13. The Mayor of the city of Stockholm is Vice Director of the Board of Electrum.

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