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Trade and Innovation Project: A Synthesis Paper

Osamu Onodera

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TRADE AND INNOVATION PROJECT

A SYNTHESIS PAPER

by

Osamu Onodera



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TRADE AND INNOVATION PROJECT

A SYNTHESIS PAPER

OECD Trade Policy Working Paper No. 72

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ABSTRACT

This paper, together with five case studies, is a part of a larger project looking at the various effects that trade and investment can have on innovation. The study looks at the role of trade and investment in technology transfer, the competition effects of trade and investment on innovation as well as economies of scale. The study also looks at Global Value Chains as an organisational innovation in its own right, which is supported by a freer trade and investment environment. The study also forms a contribution to the OECD Innovation Strategy launched at the OECD Ministerial Council Meeting in 2007.

Keywords: innovation, Multinational Enterprises, MNEs, Global Value Chains, technology transfer, competition, scale economies, licensing, intellectual property rights, TRIPs, absorption capacity, Doha Development Agenda

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The Working Party of the OECD Trade Committee discussed this report and agreed to make the findings more widely available through declassification on its responsibility. The views expressed in this paper do not necessarily reflect the views of the OECD or of its member governments. The study is available on the OECD website in English and in French: <http://oecd.org/trade>.

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EXECUTIVE SUMMARY

A driving factor for much of the economic growth and rise in living standards in the post world war II era is the rapid advances in technology and innovation. Stronger innovation and its diffusion are also considered indispensable for addressing global challenges such as climate change. There is today great interest in understanding how governments can enhance innovation and the economic benefits it should bring as evidenced in the discussions at the OECD Ministerial Council Meeting in 2007 where it was decided to task OECD to develop a broad ranging OECD Innovation Strategy. International trade and investment are considered to have contributed to innovation by allowing for a freer flow of technologies across borders, enhancing competitive pressures and opening new markets.

This paper provides an overview of the various effects that trade can have on innovation, drawing on the existing literature on this issue, as well as a number of accompanying case studies: Finland's telecommunication equipment sector, Korea's ICT sector, New Zealand's agriculture sector, Sri Lanka's garment sector and South Africa's agriculture sector.

The study finds that trade and investment can affect innovation in various ways; as sources of technology, through competition effects, and through scale economies. While trade and investment in many cases promote innovation (i.e. technology transfer through imports, increased incentives through competition, positive effects of exports on scale economies) , in some respects, trade and investment can have negative effects on innovation (i.e. negative effect of imports on scale economies, decreased rent available for innovation). **Trade and investment** is important in each of the different stages of innovation, the generation of new ideas, their implementation, and their diffusion, but **especially important in the implementation and diffusion stages**. Empirical evidence indicates that generally firms that are involved in trade and investment are more productive and innovative than purely domestic firms. **The role of trade and investment in diffusion of innovation is especially important when discussing the importance of innovation for addressing global challenges such as climate change.**

From a trade and investment policy perspective, this paper concludes as follows:

- The shift from a closed and linear innovation model to an open innovation model which requires closer coordination between constituents in a network is making a free trade and investment environment enabling freer interaction with suppliers, competitors and customers more important than ever before.
- While restrictive trade and investment policies have been and are employed on the basis of developing domestic industries, the increasing use of global value chains suggests that potential negative effects through (1) compounding of tariffs as inputs are moved inside the global value chain and (2) possible exclusion from global value chains because of a more costly environment for business, may be greater than any possible benefits of restrictive trade and investment policies.
- Global value chains driven by MNEs have been a key conduit for technology transfer and innovation: a stable trade and investment environment conducive to MNEs could promote further technology transfer and innovation.
- Small and medium enterprises constitute a large part of the economy and it is of importance for all economies to ensure that innovation by SMEs are promote. Available evidence show that SMEs who are linked to the global market are more innovative and that SMEs can make use of global value chains to improve their technology and ability to innovate.

- From this point of view, the successful conclusion of the Doha Development Agenda would contribute by lowering trade barriers for both goods and services, thereby providing access to more technology and promoting competition in the domestic market through imports on the one hand, and providing access to export markets which may be important to promote innovation in countries with smaller domestic markets, on the other. Regional and bilateral trade agreements could serve as a second best solution to the extent they support the multilateral trading system.
- Increased predictability through tariff and services commitments can also contribute to a more stable trade and investment environment and contribute to inclusion into global value chains.
- ICT products are an important driver of innovation, especially in marketing innovations and organisational innovations. From this point of view, the price effect of freer trade can have an important effect on the diffusion of ICT goods and services, and innovations based on these products. Expanding the scope and participation in the Information Technology Agreement could (1) improve access to cheaper ICT goods, which could lay the basis for the diffusion of marketing and organisational innovations and (2) open the door to participation in related global value chains in this growing area.
- Eliminating non-tariff barriers (e.g. differing standards) that impede effective competition between markets, could also contribute to greater innovation.
- In addition to trade and investment liberalisation, governments should strive to improve the business environment through further regulatory reform and by improving access to financing, and encouraging human resources development.
- Ensuring that protection of intellectual property rights on a global basis will work so as to improve technology transfer while providing sufficient benefits to the innovator to maintain robust incentives for new cutting edge innovations will be increasingly important.

TRADE AND INNOVATION: A SYNTHESIS PAPER

1. Introduction

1. **Innovation** and technological progress are **key determinants of economic growth**. Much of the economic growth and rise in living standards in the post World War II era is due to advances in technology and innovation. Continued economic growth depends on our ability to maintain and increase current levels of innovation. There is today great interest in understanding how governments can enhance innovation and the economic benefits it should bring, as evidenced in the discussions at the OECD Ministerial Council in 2007 and the decision by Ministers to ask OECD to develop a broad-ranging Innovation Strategy.

2. **Businesses are the main driver of innovation** but governments have an important role to play. Governments implement a wide range of policies to promote innovation including in the areas of R&D, intellectual property rights, education, labour markets, financial markets, as well as product market regulations. Improving the business environment for innovation is an especially important policy area and **open trade and investment regimes** are a key part of the business environment conducive for innovation, allowing for the freer flow of technologies across borders, enhancing competitive pressures and opening new markets. Both international trade and foreign direct investment are important ways in which global businesses exploit innovations on the one hand, and are important sources of innovations on the other. While the importance of trade and investment in the performance of innovation systems is well accepted, not enough is known about how trade and investment affects the innovation process.

3. To gain a better understanding of how trade and investment patterns and policies affect innovation performance and interact with other key policies influencing innovation performance, the Trade Committee initiated work on “trade and innovation”. This paper is a synthesis paper which provides an overview of how trade interacts with innovation and is accompanied by five case studies: Finland’s telecommunication equipment sector, Korea’s ICT sector, New Zealand’s agriculture sector, Sri Lanka’s garment sector and South Africa’s agriculture sector.

4. The study is organised as follows. The second section looks at the definition of innovation and underlines several issues that should be borne in mind when considering the relationship between trade and innovation. The third section discusses the links between trade and innovation. As trade and investment are increasingly interlinked, investment is also discussed in this section. This section starts with an initial overview, followed by sections explaining various aspects such as technology transfer through capital and intermediate goods and services, trade in technology through licensing, investment and diffusion of innovation, absorption capacity, competition effects of trade and investment, and benefits of exports on innovation. The fourth section looks at global value chains (GVCs) – which are an innovation in its own right which is a new organisational method in business practices. This section takes an overview of how GVCs have evolved and their effects on innovation. The fifth section concludes.

2. Definition of innovation

5. We define “innovation” for the purposes of our discussions as “the implementation of a new or significantly improved product (good or service), or process, a new marketing method, or a new

organisational method in business practices, workplace organisation or external relations”.¹ Several points should be underlined.

6. First, the types of innovation to be considered here relates **not only to product and processes** but also to **new marketing methods and new organisational approaches**. Table 1 briefly explains the four main types of innovation providing some illustrative examples.²

Table 1. Main Types of Innovation

Main type of Innovation	Explanation	Examples	Relationship with trade and investment
Product Innovation	Introduction of a good or service that is new or significantly improved with respect to its characteristics or intended uses, including technical specifications, components and materials, incorporated software, user friendliness or other functional characteristics in a product.	Introduction of ABS braking systems and GPS systems in automobiles, the use of breathable fabrics in clothing . Product innovation in services can include significant improvements in internet banking services, addition of home pick-up and drop-off services for rental cars.	Embedded technology in imported goods and services. Competition effects. Scale economies in R&D and production. Tacit technology through learning from exporting and investment.
Process Innovation	Implementation of a new or significantly improved production or delivery method.	Introduction of automation equipment on a production line or the implementation of computer-assisted design for product development. New or significantly improved techniques, equipment and software for ancillary services such as purchasing, accounting, computing and maintenance are also included.	Same as above.
Marketing Innovation	Implementation of a new marketing method involving significant changes in product design or packaging, product placement, product promotion or pricing.	Fundamental change in bottle design for a body lotion to appeal to certain new customers, introduction of new sales channels (e.g. internet, franchising, direct selling, exclusive retailing, product licensing etc.), development and introduction of a new brand symbol, introduction of a fidelity point system, first use of a new method for varying price according to demand.	Same as above. For many marketing innovations, trade in ICT goods and services may be especially relevant.
Organisational Innovation	Implementation of a new organisational method in the firm's business practices, workplace organisation or external relations.	First introduction of supply chain management systems, business reengineering, lean production and quality management systems. Workplace organisation includes implementation of new methods of decision making, and introduction of build-to-order systems. New organisation methods in a firm's external relations include establishment of new types of collaborations with suppliers, outsourcing or subcontracting for the first time of business activities in production, procuring, distribution, recruiting and ancillary services	Same as above. For organisational innovations which require ease of communication , trade in ICT goods and services may be especially relevant. Use of global value chains (a form of organisational innovation) which is based on trade and investment could be considered an innovation in its own right.

Source : First three columns based on OECD (2005) Chapter 3

1. Oslo Manual – Guidelines for Collecting and Interpreting Innovation Data (OECD, 2005a).
2. While innovations can be thus categorised, it should be noted that innovations can span more than one type: for example, introduction of a Total Quality Management Program may include both a process and an organisational component.

7. Second, the concept of innovation is not limited to **technology and knowledge creation** through R&D, but is much wider, covering **implementation or commercialisation of advances in technology**.³ Invention is of little value in and of itself unless it is put to use. The economic impact will be limited if the use is limited to a few which underlines the importance of **diffusion**. As was discussed at the OECD MCM 2007, stronger innovation and diffusion of innovation is indispensable for addressing global challenges, such as meeting increased demand for energy and food, and responses to climate change (See Box 1).

Box 1. Trade and investment: promoting the creation and diffusion of environmental innovations

With global challenges such as climate change rising to the top of the political agenda, countries are looking for new ways to nurture invention and technological innovation. The hope is that breakthroughs in environmental technologies, both products and processes, will provide the means by which the world can meet these challenges without sacrificing economic growth. But new technologies can only make a contribution to the extent that they replace older ones. The need for a rapid diffusion of breakthrough technologies is particularly urgent in those developing countries that are ramping up their production and consumption, so as to avoid locking in older, less efficient technologies (IPCC, 2007).

The global market for environment-related technologies is expanding quickly. According to one estimate, sales of environmentally related technologies has grown from approximately USD 450 billion in 1993 to USD 652 billion in 2005 (*Environmental Business Journal*, 2007). The market for cleaner energy technologies alone is projected to reach USD 167 billion by 2016 (Clean Edge, 2006). Most of the expansion of this market is expected to occur in emerging countries, especially in China, India and Brazil (OECD, 2008).

The diffusion of environmental technologies is vital to addressing the climate-change problem. The stabilisation of greenhouse gas (GHG) concentrations in the atmosphere can be achieved more efficiently by globally deploying technologies and technologies that are expected to be commercialised in the coming decades in the energy supply, transport, buildings, industry, agriculture, forests, and waste management sectors (IPCC, 2007). China, India, and Russia already contributed 19%, 4% and 6% of global CO₂ emissions from fuel combustion in 2005. Though per capita GHG emissions in these countries -- 3.9 tonnes of CO₂-equivalent (tCO₂-eq) in China, and 1.1 tCO₂-eq in India -- are well below the OECD average of 11.02 tCO₂-eq, it is certain that GHG emissions in these countries will increase as their economies grow. A doubling of GDP in these countries is expected to lead to a 30% increase in global emissions if they continue along the current trajectory. However, as tCO₂ per unit GDP in China (2.68) and India (1.78) are considerably higher than in the OECD (0.45), there is considerable room for keeping CO₂-emission growth lower by promoting the use of environmental technologies in these developing countries.

Trade and investment can promote new innovations and encourage their diffusion. First, goods and services embodying environmental technologies can themselves be channels of diffusion. Preliminary work by the World Bank (2008b) finds that a removal of tariffs and non-tariff barriers for four basic energy technologies (wind, solar, clean-coal, and efficient lighting) in 18 of the high-GHG-emitting developing countries would result in trade gains of up to 13 percent, which in turn could facilitate diffusion of these technologies. Second, the creation of a bigger market through trade may provide sufficient economies of scale to invite further R&D investment in environmental technologies. From this point of view, the problem of differing national standards could pose a barrier to the creation of a unified market for environmental products and processes.

A considerable amount of technology transfer occurs through foreign direct investment (FDI). Many multinational companies have internal environmental policies, some of which are more stringent than the laws and regulations of the countries in which they operate. When multinationals from a country with stricter regulations invest in countries with lower regulations they often adhere to higher levels of environmental friendliness, in part to maintain their company's reputation. Global value chains are also becoming pathways for technology diffusion. With increasing cross-national outsourcing to suppliers, better environmental performance spreads upstream through the supply chain. Many companies impose an obligation on suppliers to meet particular environmental requirements. Finally, partnerships and technical-cooperation between companies are facilitating R&D in environmental technologies, thus allowing companies to share costs and risks linked to R&D.

There is a certain level of tension between the creation of new environmental technologies and the diffusion of

3. Schumpeter divides the technological change process in three stages, invention, innovation, and diffusion of innovation (Stoneman, 1995). The invention process encompasses the generation of new ideas. The innovation process encompasses the development of new ideas into marketable products and processes. The diffusion stage is when the new products and processes spread across the potential market.

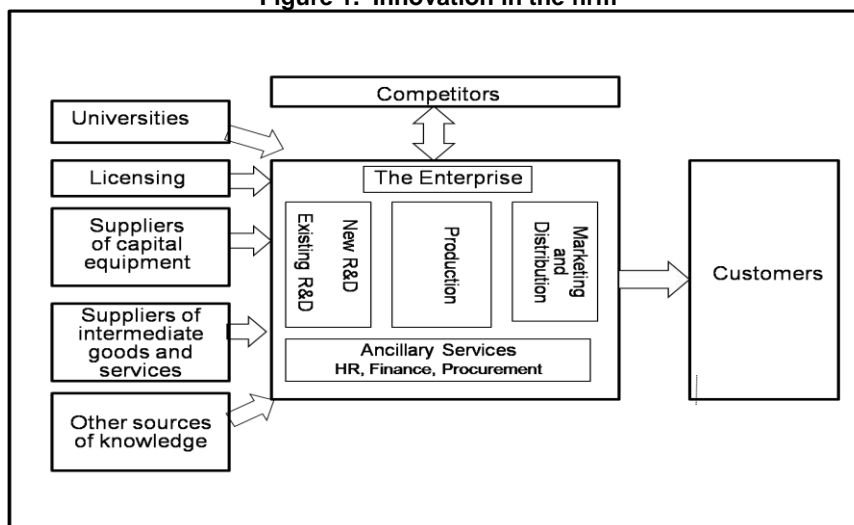
innovation. In order to promote the creation of new technologies, inventors demand protection, through patents and other forms of intellectual property rights (IPRs), from imitation. It is important, however, that policies to protect intellectual property rights strike the right balance between ensuring that invention and innovation are rewarded while enabling these new technologies to be diffused rapidly. Furthermore, ways have to be found to keep down the cost of applying these technologies in developing countries, without compromising the rewards due successful initial innovators. The tension between the need to promote creation of new technologies and the social need to promote diffusion became evident in the context of the discussion of trade-related intellectual property rights (TRIPs) and public health, where the need to maintain an incentive for pharmaceutical companies to develop new drugs was balanced with the need for poor developing countries to have access to affordable drugs.

Countries can do several things to facilitate the flow of environmental technologies: (1) reduce barriers to trade in environmental goods and services; (2) reduce barriers to foreign direct investment; (3) maintain an international intellectual property protection regime which facilitates the diffusion of technology while providing sufficient rewards to the initial inventor; (4) use transparent and non-discriminatory government procurement practices that provide predictable markets for environmental goods and services; and (5) harmonize international standards and conformity assessment procedures. Linked together with other policies to facilitate development of environmental innovations and their diffusion, freer trade and investment can make a measurable contribution to meeting global challenges.

Source : Based on OECD(2008 – ENV/EPOC/GSP(2007)2/REV2). Figures on CO2 emissions from IEA(2007).

8. While innovation in the firm has been described as a linear process⁴ that starts with (1) research and development (including design), followed by (2) manufacturing, then (3) marketing and distribution with the new product reaching the consumer, with various ancillary services such as human resources, finance, information technology and procurement providing support (see Figure 1), in reality there are numerous feedback loops and innovation is increasingly realised in a network.⁵ It is worth highlighting that sources of innovation can vary from internal R&D, new capital equipment, reverse engineering, imitation, licensing agreements and collaboration agreements with other companies, and learning from other sources, for example on the factory floor.

Figure 1. Innovation in the firm



4. There are two views on how innovations are implemented and diffused; the “technology push” view and the “demand pull” view. Under the former, technological change occurs as a result of the emergence of new technologies and knowledge, while under the latter, it occurs as a result of corporate investments in response to demand. In reality both push and pull factors affect innovation and diffusion.

5. For example, numerous product ideas come from consumers, an increase in sales would feed back as resources for additional research, the manufacturing process could provide feedback to the development of new “easy-to-manufacture” products, etc.

9. Innovations are most often a **combination of existing and new technologies and competences inside and outside of the innovating organisation**. Large multinationals are moving towards a *double network structure* with an internal network of units that are involved in the company's use, generation and absorption of knowledge on the one hand, and numerous external networks where the respective internal units are linked with other firms and institutions that are located outside, in order to increase the potential for use, generation and absorption of knowledge (Zanfei, 2007; Castellani and Zanfei 2006). No firm, not even a dominant market leader can generate all of the different capabilities internally that are necessary to cope with the requirements of global competition (Ernst, 2003). Often firms may decide not to exploit all of the ideas that emerge in a firm either due to resource constraints or because it is not compatible with its business strategy. Thus there is an increasing emphasis on strategic alliances in R&D and other areas, outsourcing and the use of production networks. In a related development, the closed and linear innovation model is increasingly moving to **an open innovation model** where innovation is being realised in a network (see Box 2).⁶

Box 2. From a "closed and linear innovation model" to an "open and global network innovation model" – the case of IBM

The way companies organise, manage and conduct their innovation is significantly changing. In the past, a "closed innovation" model of R&D departments developing technology for use only within the company (e.g. Bell laboratories) was the main corporate model for innovation. This model is increasingly becoming obsolete. Firms are moving **towards a more open system of innovation** where innovation is created through interactions within and outside the company (suppliers, competitors, customers, universities, research organizations) (Chesbrough, 2006). In this new paradigm of "open innovation," firms source ideas and technology both internally and externally, and become more permeable to the flow of knowledge from outside the company. They also find new ways of exploiting their own inventions, such as through spin-off companies, licensing technology or releasing intellectual property in the public domain.

IBM provides a good example. Until the 1980s, IBM was a typical example of a vertically integrated firm. IBM was then the global leader in mainframe computers, and did everything in-house from R&D, system development, component manufacturing, system and subsystem assembly, software development, to distribution and servicing. A massive process of vertical specialization segmented the once vertically integrated mainframe computer industry into closely interacting horizontal layers (i.e. microprocessor production led by Intel, operating software led by Microsoft, and a commoditised personal computer industry). IBM realized that it was no longer realistic to tightly control use of its component technologies since abundant specialized knowledge had dispersed to other companies and countries. IBM decided to adopt open standards in a variety of areas including the Linux OS, the Java programming language, HTML, and http protocols while shifting the focus of its innovation management to technology licensing. IBM has increasingly shifted to position itself as a solution provider which uses the best available technology whether internal or external. IBM's strategy has led it to sell its PC business to Lenovo a growing Chinese company while its licensing revenue grew from \$30 million in 1990 to \$1.9 billion in 2001.

IBM has also changed its global strategy as innovation is increasingly drawn from all over the world. Whereas in the first era of internationalisation, IBM maintained most of their various functions at head quarters and exported, and in the second era of multinationals, it replicated subsidiaries abroad, today IBM has become a globally integrated enterprise where company functions are realised where it is most efficient. As such, in the case of IBM, it has focused most functions (procurement, manufacturing, finance, human resources, R&D) to a limited number of countries, the most notable being the reduction of the number of procurement centres from 300 to 3 (Budapest, Hungary, Bangalore, India, and Shenzhen, China) in the last 6 years. Country offices can harness the capability of other offices. For example, in servicing a Swiss client, a Swiss office can receive computer data support from India, software support from Brazil, and procurement services from Budapest. The sources of competitive advantage and innovation no longer reside in one country. Thus in IBM work "flows" to the location where it can best be done. Nations, companies and people can quickly lose their differentiation and competitive advantage so there is a need for adapting, reinventing and transforming – innovating.

The shift to an open innovation model leads to **an increase in the importance of free trade and investment in**

6. There is an ongoing project in STI on the open innovation model with a final study to be submitted in April 2008 [DSTI/STP(2008)10].

the innovation process, as freer trade and investment leads to freer interaction with suppliers, competitors, and customers. **Increased emphasis on the exploitation of patents through licensing technology** implies that **international protection of IPR becomes more important** to facilitate innovation and the diffusion of innovation.

Source : Based on Chesbrough (2006), Ernst (2006) and Gregory (2007)

10. Third, **innovation** is not restricted to a “global first” or “new to the world” (i.e. the introduction/application of technology for the first time in the world), but **includes “new to the firm” or “new to the market”** (i.e. the introduction/application of technology for the first time in a new environment, be it a firm or a market).⁷ Such a broad view of innovation is appropriate as we are interested in innovation and diffusion of innovation as they affect **growth** both in developed and developing countries.

11. Fourth, **innovation** (both creation of new technology and subsequent commercialisation) is inherently a **risky undertaking**, as it is about bringing together knowledge and resources (capital, labour, management resources etc.) when the **returns are uncertain**.⁸ When substantial investments are needed for commercialisation, the general business environment may constrain the ability of companies to invest in innovation (see also later section on absorption capacity). As many innovations fail to be realised at the commercialisation phase, it is necessary to be mindful of how risks⁹ related to innovation and the costs of bringing resources together can be minimised in designing national innovation systems¹⁰ and innovation policy.

12. Fifth, innovation can be characterised as a **process of trial and error**. As Edison said of old “Genius is one percent inspiration, ninety-nine percent perspiration.” This latter characteristic of innovation as a trial and error process means that the less expensive a “trial” is the more trials can be conducted and the greater the probability of successful innovation. In so far as trade plays a role in the innovation process, lower trade costs would lead to lower costs for a given trial, the greater the number of trials that can be made and greater the possibility of successful innovation.

13. Sixth, **knowledge accumulation** plays an important role in the innovation process because innovation is a combination of existing and new technologies and competences inside and outside of the innovating organisation. **Size and distance from knowledge frontiers matter** as while some outside knowledge is tacit and does not travel very far. The larger the domestic economy, (presumably) the greater the amount of internal knowledge than can be used and the less need for drawing on outside knowledge which complements internal knowledge to realise a new innovation. The more physically distant a country is, the more costly it would be to tap into external knowledge. Thus trade becomes an especially important component of growth (and innovation) strategy for smaller countries such as New Zealand and Finland,

7. The market is defined both by geographical region and product line. Thus even if there are existing firms selling books over the internet, a firm selling automobiles over the internet are implementing innovations “new to the market”. Some (e.g. Enos and Park, 1988) refer to this wider process of innovation as adoption, absorption and adaptation.

8. It should be noted that as indicated in Box 2, “nations, companies and people can quickly lose their differentiation and competitive advantage” so there is a need for adapting, reinventing and transforming – innovating - not innovating or not adapting may be an equally risky course of action.

9. For example, risks would be extremely high in countries under conflict or which are politically unstable. Countries where economic policies are highly untransparent and volatile may also be risky, deterring innovation.

10. A national innovation system refers to the network of institutions in the public and private sectors whose interactions determine the innovative performance of a country. See OECD (1997) for various definition of national innovation systems.

while it is relatively less important for larger countries such as the United States and Japan. As firms increasingly make use of the global pool of knowledge and global markets for innovation, it is increasingly questionable whether this assumption that trade and investment are relatively less important for larger countries holds.

14. Finally, innovation can also be characterised as a process of “creative destruction”, a term coined by Schumpeter. Innovation can provide benefits for the innovator and those who utilise the fruits of innovation. To the contrary, innovation can impinge on existing arrangements: competitors and workers who were involved in the supply of the now obsolete products may suffer and be required to adjust. Trade and investment, as it is often one factor leading to innovation, can be characterised as a harbinger of change. This characteristic of trade and innovation can lead firms and workers affected by change to ask for the introduction of protectionist measures. This points to the importance of complementary policies to facilitate structural adjustment, including social safety nets (OECD, 2005) in order to maintain wide support for free trade and investment.

3. The effects of trade on innovation

(1) *The role of trade and investment in innovation – an overview*

15. Economic theory finds that trade can lead to substantial economic benefits through more efficient allocation of resources and deepening specialisation allowing countries to profit from comparative advantage (so called static gains from trade). This is the basis for most of the economic models used to calculate the benefits of trade such as GTAP. However, economic theory also suggests that trade can lead to **dynamic gains** in addition to these static gains (Nordas et al, 2006). Transfer of technology and innovation are considered a main source of dynamic gains although it has been difficult to gain conclusive evidence.

16. There is a two way link between trade and innovation. Innovation gives birth to technological advantage, which together with differences in factor endowments, are the source of comparative advantage which in turn drives trade. Thus technology gaps have been found to be one determinant of trade and investment.¹¹ Developed countries tend to export high-technology goods compared to developing countries. Innovative and more productive companies export, invest abroad or license their technologies to exploit the benefits of their innovations. As such, open markets would benefit innovative firms. Open markets lead to an increase in the size of the market over which the firm can exploit its innovation and realise monopoly profits.

17. On the other hand, trade and investment affect innovation in various ways such as technology transfer, competition effects, scale economies and spill-overs (learning from exporting, learning by investing) (see Table 2). Trade and investment affects each of the stages of business through these various effects. Figure 2 tries to illustrate this using the example of product innovation in a manufacturing company. The arrows in solid black show where trade and investment play a dominant role, and the striped arrows shows where trade and investment are only indirectly related.

11. Vernon’s *product lifecycle* model is one such example. Vernon developed a model where innovative products are first manufactured in the technological leader country, and as the technology becomes standardised, firms decide to locate production abroad in order to counter increasing competitive threats and to take advantage of lower costs abroad. Under this model, innovative products will initially be exported from the technology leader country to other countries, and the trade pattern will reverse as the technology matures.

Table 2. Various effects of trade and investment on innovation

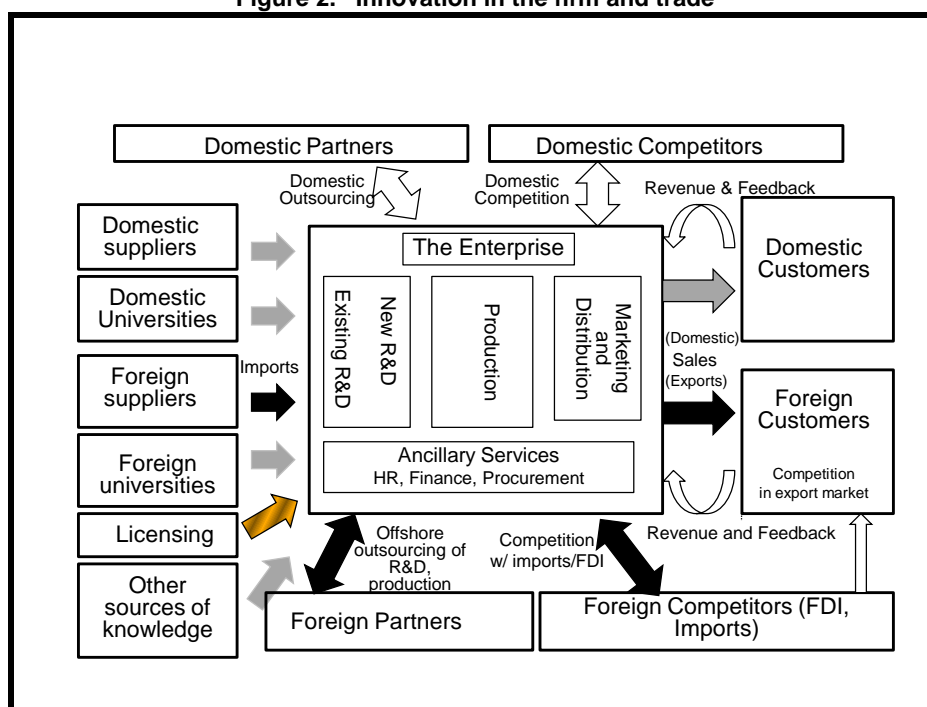
Mode	Effect on Innovation		Positive /negative	Supplementary Explanation
Imports	Technology transfer	technology effect	+	More important for developing and smaller countries. Importance increasing due to increasing convergence of technology.
		price effect	+	Important for network products such as ICT.
	Competition		+ or -	Decreased rents can lead to decrease in resources available for innovation. Competition generally increases incentives to innovate. For firms far below the technology curve, sudden increase in competition can decrease innovation.
		Scale economies		(-)
Exports	Competition		+ or -	Competition generally increases incentives to innovate. For firms far below the technology curve, sudden increase in competition can decrease innovation.
	Scale economies		+	Especially important for countries with smaller domestic markets.
	Learning from exporting		(+)	Considerable differences depending good and/or export market
Licensing	Technology transfer		+	Importance increasing due to increasing convergence of technology (e.g. broadcasting and telecommunications, automobiles and electronics).
Inward FDI	Technology transfer		+	MNEs have better technology than purely domestic counterparts. Joint ventures can enhance technology transfer.
	Competition		+ or -	Competition generally increases incentives to innovate. For firms far below the technology curve, sudden increase in competition can decrease innovation.
	Spill overs		(+)	MNEs can have spill-over effects through imitation and demonstration, worker mobility and spin-offs, backward and forward linkages
Outward FDI	Technology sourcing		+	MNEs invest abroad to source foreign technology and also to use the foreign pool of research talent.
	Learning by investing		+	Application of technology in new environments provide opportunities for knowledge creation. The effect of FDI on productivity would be negative if the investment project itself fails even if there is a positive effect in terms of knowledge within the firm.

18. In the research and development stages, the import of the most up-to-date scientific equipment is of importance. For example, even the United States, which is at the global frontier in scientific equipment imported roughly 25% (\$ 1.9 billion) of analytic and scientific instruments (except optical) used domestically in 2006.¹² In addition, most companies now either use research conducted in universities and other companies through licensing agreements often with international partners. Both FDI and temporary movement of natural persons play increasingly important roles in the R&D process. Trade can also provide an incentive for greater R&D through competition – competition from new entrants often force companies to develop new products with new features. Exports also allow companies to cover R&D costs which may not be possible if these countries only produced for the smaller domestic market.

19. Trade and investment play an integral role in providing innovative inputs the manufacturing stage. Imported capital goods and intermediate products play an important role as conduits of technology, as does FDI in upstream industries. Competition from imports and FDI in the domestic market and competition in export markets act as strong incentives for firms to innovate.

20. In a similar manner, trade and investment play vital roles in process innovations, marketing innovations and organisational innovations. Imported capital goods are often the main source of process innovation in developing countries. Information and Communication Technology has been the main driver of recent marketing and organisational innovations, and trade in ICT goods have been a major enabler of innovation in these areas.¹³

Figure 2. Innovation in the firm and trade



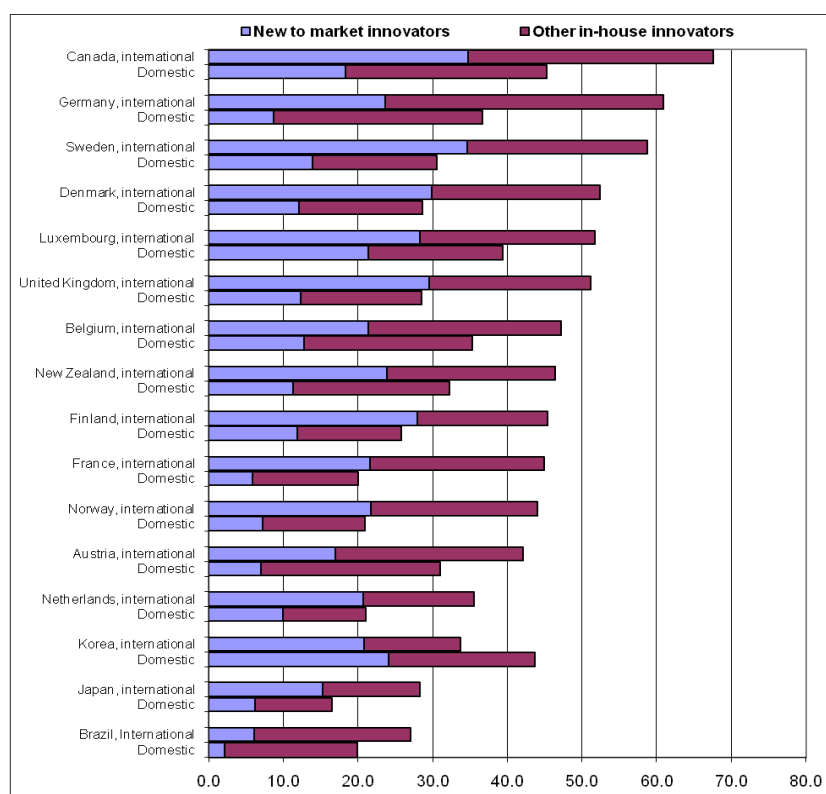
12. According to U.S. Census Bureau (2007), there were 8.6 billion USD of domestic shipments, 3.0 billion USD of exports and 1.9 billion USD of imports for consumption for analytical and scientific instruments (except optical [NAICS code 3345160] which means that the domestic market was 7.6 billion USD. Analytical and scientific instruments include chromatographic instruments, spectrophotometric instruments, thermal analysis instruments, DNA sequencers, gas detectors etc.

13. See later Box 3 on ICT as a driver of innovation.

21. International production networks created with foreign partners and involving offshoring/outsourcing (also coined as trade in tasks) have been an organisational innovation which has increased efficiency in the manufacturing process. Specialisation based on comparative advantages allows people and companies to do what it can do best. Trade in goods, services, and increasingly tasks lead to enhanced overall productivity gains. In addition, by allowing people or companies to focus their innovation efforts, specialisation can promote innovation and productivity improvement. For example, leading brands of clothing can enhance their innovation by focusing on the design and marketing of products, and not expending resources on manufacturing. On the other hand, contract manufacturers can enhance innovation by focusing on logistics and manufacturing. International trade and cross-border investment allows this specialisation to be realised on a greater scale. For smaller economies, export markets provide an avenue to achieve economies of scale necessary for R&D and production on a globally competitive basis.

22. Recent results gained from the OECD Innovation Microdata project which analyses microdata gained from innovation surveys confirm that trade and investment is an important driver of innovation. Figure 3 shows shares of in-house innovative firms¹⁴ operating only on domestic markets and those operating internationally. With the exception of Korea, shares of innovative firms among international firms are substantially higher than for firms operating on domestic markets only. This suggests that exposure to international markets either has a strong positive effect on firms' incentives to innovate or on their ability to innovate.¹⁵

Figure 3. In-house innovators for domestic and international markets, 2002-2004¹



1. For New Zealand : 2004-2005, for Japan: 1999-2001, for Brazil: 2003-2005.

Source: DSTI/EAS/STP/NESTI(2008)14 Figure 8, OECD Innovation Microdata project, 2008.

14. Based on the output-based innovation modes, it is not possible to divide adopters according to market orientation.
15. Baldwin and Gu (2004) look at microdata in Canada and find that exporters use technology more intensively and have higher rates of innovation. See also later section on learning from exporting.

23. The following sections look in greater detail at three ways in which trade can affect innovation: increased technology transfer, competition and economies of scale in turn. The focus first is on the technology transfer aspects, looking initially in section 2 at the role of imported capital and intermediate goods and services, followed by section 3 on licensing as a direct means of technology transfer and section 4 on investment. This is followed by section 5 which looks at some of the limitations to trade and FDI as a means of technology transfer in terms of absorption capacity. Section 6 looks at the competition effects of trade and investment on innovation, followed by section 7 which then consider how trade and investment affects innovation through scale economies and learning through exporting.

(2) *Trade in goods and services as a means of technology transfer and diffusion of innovation*

24. First of all, trade is an **important conduit for the international transfer of technology and diffusion of innovation**. New technologies can be transmitted across countries through different activities,¹⁶ for example, through trade in capital goods and intermediate goods and services, both inward and outward foreign direct investment, movement of natural persons, contact with suppliers and customers, licensing agreements, and learning by doing. Multiple channels are often used and it is extremely difficult to isolate the effects of each channel.¹⁷

25. Imports of capital goods/inputs are recognized as an important conduit for technology diffusion as **foreign machinery can embody more technology than domestic machinery**, especially in the case of developing countries (Table 3). A number of empirical studies support such conclusions,^{18,19} and there is a wealth of supportive evidence based on case studies. For example, Samsung predominantly imported semiconductor manufacturing equipment from the US and Japan when creating its dominance in DRAMs (Dynamic Random Access Memories). Imports into India of computer hardware were critical in enabling India's software export industry to achieve technological parity, as were pre-cooling equipment for grape exports in India, palm oil refineries in Malaysia, fish tanks and other equipment for salmon farming, tanks and barrels for wine making in Chile, and greenhouses for floriculture in Kenya (Chandra eds., 2006). Survey data also provide evidence. For example, over 60% of companies in both LDCs and other

16. Different sources of technology may have different characteristics. A main distinction could be drawn between codified knowledge that could be transmitted without further human intervention and tacit knowledge which requires person-to-person interactions to be transferred and therefore could not be 'embodied' neither in goods or in scientific publications (on the sources of diffusion of tacit knowledge see OECD 2001). Trade openness affects both sources of technology not only improving access to codified and explicit knowledge but also increasing what Freeman (2004) defines as "the general openness of a society and the movement of people and ideas".

17. As noted in Chandra eds (2006) which looks at 10 cases of technology transfer and adaptation in developing countries, "a single magical channel for the successful transfer of new technologies does not seem to exist."

18. A number of studies such as Coe and Helpman (1995), Keller(2004), Eaton and Kortum (2001) find that imports play a significant role in international technology transfer. Xu and Chiang (2005) find that productivity in advanced countries benefits from foreign technology embodied in imported capital goods. Eaton and Kortum (1996) and Bernstein and Mohnen (1998) find that R&D spillovers from the US to Japan are more significant than the other way round which suggests that it is trade with the technological leader that matters.

19. Coe et al. (1997) find that total factor productivity in developing countries is positively and significantly related to R&D in their industrial country trade partner and to their imports of machinery and equipment. Kasahara and Rodrigue (2007) analyses Chilean firm data and find that the use of imported intermediates led to an immediate 2.6 percent positive productivity effect and possibly additional dynamic effects. Amiti and Konings (2005) studies Indonesian plant level data and find that a 10 percentage point fall in tariffs leads to a 3% productivity gain on average and an 11 % productivity gain for importing firms.

developing countries found machinery and equipment to be one of the top three sources of technological innovation (Knell (2006) cited in UNCTAD, 2007), and this has been supported by other survey data.²⁰ While the introduction and use of new capital goods into new contexts may constitute a one time innovation, this does not ensure any further may not lead to any be insufficient to put in place a more dynamic process of innovation. Korea's experience illustrates how considerable R&D and investment in human resources is necessary to put in place a more dynamic system conducive for ongoing innovation.

26. **Trade in intermediates** is growing²¹ and domestic production increasingly relies on technology gained from foreign inputs as a source of innovation.²² For example, one study which analyses firm-level data in a large group of developing countries finds that all else constant, importers are 7.6 percentage points more likely to adopt new technology than firms that do not engage in such activity (Almeida et al., 2006). Technology gained through intermediate products may especially be important for exporters who are subject to greater international competition.²³

Table 3. Relative importance of various channels of technology transfer

Sectors	FDI	Licensing	Import of capital goods/inputs	Local industry development/participation	Contracts/consultants	Local R&D	Diaspora, tech parks
Software in India	Low	n.a.	High	High	Medium to high	Low	High
Electronics in Chinese Taipei	High	High	High	High	Medium to high	High	High
Electronics in Malaysia	High	Low	High	Low	Medium	Low	Medium
Oil palm in Malaysia	Low	Low	High	High	Low	High	Medium
Salmon farming in Chile	High	n.a.	Medium to High	High	Low	Medium to low	n.a.
Wine in Chile	Medium	n.a.	High	High	High	Medium to low	n.a.
Grapes in India	n.a.	n.a.	High	High	Medium to high	High	n.a.
Maize in India	Low	High	Low	High	n.a.	Medium to high	n.a.
Fisheries in Uganda	High	n.a.	Medium	Low	High	Low	n.a.
Floriculture in Kenya	Medium to High	High	High	Medium to High	High	Low	n.a.

Source : Based on Table 1.3, Chandra eds. (2006)

27. While the technology embedded in imported capital and intermediate goods are undoubtedly of great importance, the **technology diffusion effect through lower price** is of no less importance. Studies have found that the price of capital goods can be higher in developing countries: in such as case, the use of cheaper foreign capital equipment can contribute to more efficient capital accumulation.²⁴ One study

20. For example, in Brazil and Argentina, it is found that the technological innovation efforts of both countries are mainly driven by the purchase of capital goods (De Negri and Turch (eds.), 2007). Firm level data set covering 43 developing countries used by Almeida et al. (2006) also report that on average 53% of the technological innovations were embodied in new machinery or equipment.

21. See also later section on "Global value chains as observed in the data".

22. Before NAFTA, Mexican refrigerators were of low quality due to the low quality of domestic compressors. Following NAFTA, a Mexican refrigerator manufacturer imported much better American compressors and became one of the largest suppliers of refrigerators to the US market (Krueger as cited in Amiti and Konings (2005).

23. In Brazil, it is pointed out that Brazilian exporters that innovate require more imported components and other inputs to maintain their international competitiveness because Brazil is partially or totally non-competitive in many high-tech segments (De Negri and Turch (eds.), 2007 page 46).

24. Lee (1995) looks at cross country data for the period 1960-85 and finds that the ratio of imported to domestically produced capital goods in the composition of investment has a significant positive effect on

estimates that there could be up to a 4.5 times difference in the price of equipment between developed and developing countries depending on domestic levels of technology and access to foreign capital goods through trade (Eaton and Kortum, 2001).

28. The cost effect of imports may be especially important for ICT goods and services²⁵ which are closely related with the uptake of marketing and organisational innovations. For example, the introduction of mobile phones to fishermen in India led to an increase of 8% of profits for fishermen and a decline of 4% in consumer prices as fishermen could use the mobile phones to call several nearby markets from their boats to establish where their catch will fetch the highest price (Jensen(2007) cited in the Economist, May, 10, 2007). OECD studies have found that investment in ICT goods and services has been positively correlated with the uptake and diffusion of innovation (See Box 3).

Box 3. Information and Communication Technology as an Innovation Driver

OECD studies have found that investment in Information and communication technologies (ICT) is positively correlated with uptake and diffusion of innovation. The use of ICT is closely linked with the ability of firms to innovate, i.e. introduce new products, services, business processes and marketing methods. This is because the process of innovation is about bringing together new and existing knowledge, and different resources, which is often in different organisations, parts of the organisation or individuals. ICT facilitates the sharing of knowledge both in terms of time and costs. This is the case in all sectors including manufacturing but particularly applies to the services sectors such as finance, business services and distribution who have been found to be intensive users of ICT. Internet marketing and international outsourcing of various services are but examples where ICT have led to innovations in the services sector.

ICT is a special product in that it is both income and price elastic. ICT is income elastic because as income grows, demand for ICT products grows faster. For example, in a large number of countries such as Ireland, Singapore and Korea, ICT spending grew at twice the rate of real GDP growth of around 4%. ICT is price elastic so demand for IT products increases more than one-for one with declines in price, which means that even as price declines, total ICT expenditures increase (Cette et al., 2005; Mann, 2005). These characteristics mean that the ICT is an ideal growth industry because as global GDP grows, the demand for IT products will grow faster.

OECD (2004) suggests that the diffusion of ICT among countries is different for several reasons such as differences in the cost of ICT (both in capital goods and communication), firm specific barriers to ICT use, and the business environment. Tariff barriers and non-tariff barriers related to standards, import licensing and government procurement, together with the state of competition partly explain price differences in capital goods between countries. The Information Technology Agreement in 1997 has contributed to diffusion of ICT through the lowering of price differentials between countries. The high effect of IT diffusion on productivity and the high price elasticity of IT products taken together mean that the lower prices from globalisation has a much greater productivity effect than otherwise. This would imply that further expansion of the ITA both in terms of geographical coverage and product coverage can contribute to greater diffusion of ICT, and greater innovation.

However, OECD (2004) also finds that ICT investment needs to be complemented with changes in workplace practices and business processes to reap the full benefits of ICT.¹ Both countries with strict product market regulations and countries with strict employment protection tended to have lower levels of ICT investment. This may be because ICT investment does not lead to significant benefits unless coupled with accompanying changes in workplace practices and business processes. Thus a strategy of increasing access to lower priced ICT goods needs to be coupled with policies to dismantle barriers to changes in workplace practices and business processes to enable the full benefits of ICT to be reaped.

Source : Based on OECD (2004), Mann (2007)

1. See also other studies such as Brynjolfsson and Hitt (2003) which find from firm-level data that computerization has both a short term return on investment and greater long term returns which can be as much as between two and five times as much as the short run impact coupled with other complementary investments and innovations.

per capita income growth rates across countries, in particular in developing countries. The differences in capital goods prices and more efficient accumulation of capital is provided as a possible explanation for such effects.

25. Cost is especially important for ICT goods because they have network effects. This means that the productivity enhancing effect of ICT products are limited unless other people have them. The wider the network the greater the effect.

29. Thus described, one may think that imports are not important for technology leaders with large economies that focus more on “first in the world” innovations.²⁶ It is true that developing economies and smaller economies are generally more reliant on foreign technology but it can be no less important for large developed economies. For example, according to the European Innovation Survey, 50 percent of total innovation expenditure is embodied in plant, machinery and equipment purchased by industrial firms, with own R&D accounting for just 20 percent (Evangelista et al., 1998). A study using Japanese firm level data²⁷ find that “(firm’s) imports have significantly positive effects on productivity growth as driving forces of innovation” and that “imports contribute to accelerating the speed of catch-up”.

30. **Trade plays an important role for “first in the world” innovation** by increasing the pool of technology available for the domestic innovation process. Innovative products in the present are a combination of various technologies, which can no longer be provided by one company alone.²⁸ Technology can be either embodied in goods or can be disembodied (be in a person’s head), and both are important. Trade in goods plays an especially important role in the transmission of technology embodied in goods. Trade in services (telecommunications, transport, R&D, other services), FDI and movement of natural persons may be more important in the transmission of disembodied or tacit technologies. Open trade and investment regimes allow innovators to access embodied and disembodied technologies at minimal cost, thereby facilitating innovation.

31. Trade plays an especially **important role for “first in the world” marketing innovations and organisational innovations**. As stated above, ICT plays an important role in marketing and organisational innovations. The **technology diffusion effect of trade through lower price of ICT goods** has played an important role in the recent marketing and organisational innovations in leading technology markets such as the US. One estimate suggests that globalisation of IT hardware resulted in IT prices some 10 to 30 percent lower than they would have been based on domestic production and domestic technological advances alone in the 1990s in the United States, which could have made US GDP some \$250 billion higher over the 1995 to 2000 period than it would have been had there been no globalisation of IT hardware (Mann, 2003).

(3) *Trade in technology through licensing*

32. Patents are also an important source of technology, and technology can be traded directly through licensing. Protection of intellectual property rights and a well-functioning technology licensing market are an increasingly important part of an effective innovation system. International licensing worldwide has grown steadily since the mid 1980s. International receipts for intellectual property (including patents, copyrights, trademarks, etc.) increased from USD 10 billion in 1985 to approximately USD 110 billion in 2004 with more than 90% of the receipts going to the three major regions: the European Union, Japan and the United States (OECD, 2006b. See Figure 4). While royalty and licensing

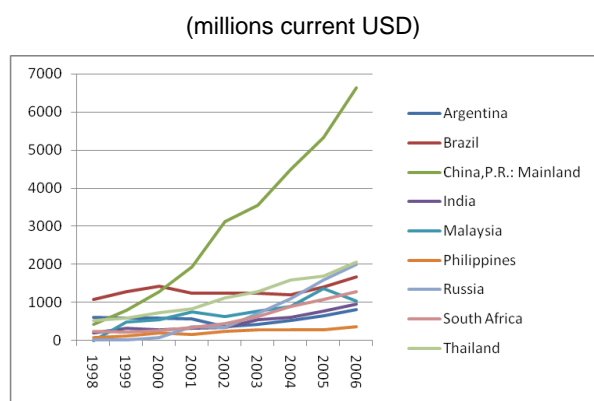
26. Investigating productivity growth in a panel of 14 UK manufacturing industries for the period 1979-92, Cameron, Proudman, and Redding (2005) find that openness to trade matters significantly for the speed of technology transfer from the United States to the UK but not on the rates of innovation. This may indeed show that trade is important for technology transfer but not for “first in the world” innovation.

27. Nishimura et al. (2005) looks at a large scale data set of Japanese manufacturing and non-manufacturing firms between 1994 and 2000.

28. Mann (2006) points out that an Apple iPod includes “a hard drive from the Japanese company Hitachi, a battery from Sony (also Japanese), a controller semiconductor chip from California-based PortalPlayer Inc., a stereo digital-to-analog converter from Wolfson Microelectronics in Edinburgh UK, a flash memory chip from Sharp Electronics (Japan), an interface controller from US-based Texas Instruments, and a power management and battery charger from Linear Technologies in California”.

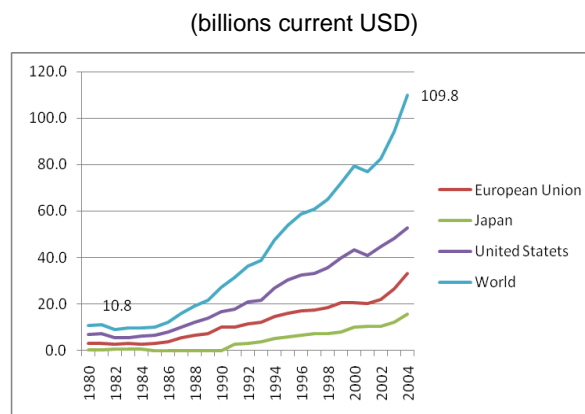
fee payments by some middle income developing countries have increased (Figure 5),²⁹ some emerging economies such as China and Israel are finding their place on the global technology map as patent owners, which shows that the global market for technology is increasingly global (Figure 6).

Figure 4. Royalties and license fees payments



Source: IMF statistics online

Figure 5. Receipts from international licensing in major OECD regions



Source : OECD(2006b)

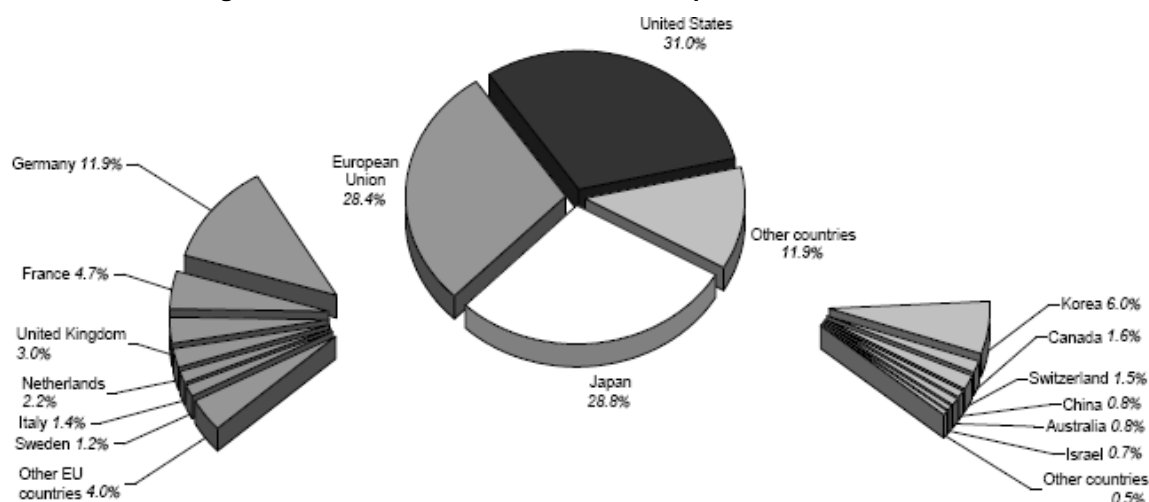
33. Licensing increases the efficiency of innovation processes by putting inventions in the hands of those best capable of commercialising them. Licensing allows the licensor to recoup some of the costs of developing the technology, while the licensee gains the right to use the technology, and possibly gain access to detailed information on the technology depending on the terms of the contract. Some studies have found that patent purchases can be more effective than R&D to increase productivity,³⁰ and this may be especially the case for developing countries and countries with low R&D productivity. Licensing enables rapid acquisition of product and process know-how, while preserving local control over adaptation and modification, but requires a significant level of local technological capability to put licensed technology to work (Chandra eds., 2006).

34. Licensing alliances tend to increase as developing countries' level of technology evolves (Table 4). With the growing importance of international strategic alliances, joint ventures and co-operation agreements, the importance of an appropriate regime of intellectual property rights is increasing in developing countries aspiring to promote technology transfer (Box 4). It should be noted that while technology transfer through licensing can be of great benefit to developing country firms, some conditions attached to licensing contracts such as restrictions on sales area³¹ could limit the licensee from benefiting more in the medium term while limiting competition.

29. Korea for example paid licensing fees of 565 million USD in the period 1962-81 (Enos and Park, 1988).

30. De Negri and Turch (2007) find that extra-mural R&D is four times more important than intra-mural R&D, and external acquisition of technology through licensing and the purchase of knowledge, patents, trademarks and consulting services, plus the signing of technology transfer agreements are markedly relevant in Brazil and Argentina (De Negri and Turch (eds.), 2007 page 19). Nishimura et al. (2005) find through an analysis of Japanese firms that patent purchases led to greater productivity gains than R&D.

31. It should be noted that such conditions do make the underlying license cheaper for the licensee. In the absence of such conditions, the license may be more expensive or the licensor may decide not to license.

Figure 6. Share of countries in total triadic patent families, 2005

Notes: Patent counts are based on the earliest priority date, the inventor's country of residence and fractional counts. Data mainly derives from EPO Worldwide Statistical Patent Database (April 2007).

1. Patents all applied for at the EPO, USPTO and JPO. Figures from 1998 onwards are estimates.

Source: OECD, Patent database, June 2007.

Table 4. Licensing alliances involving developing and emerging markets: top 20 country pairs, 1989-2002

	Licensor nation	Licensee nation	Cross-border licensing deals between firms
1	United States	Korea	73
2	United States	China	51
3	United States	Chinese Taipei	42
4	United States	India	28
5	United States	Singapore	26
6	United States	Hong Kong	19
7	Japan	Korea	18
8	United States	Russia	15
9	United States	Brazil	14
10	United States	Mexico	14
11	Canada	China	13
12	Canada	Korea	13
13	United States	Israel	11
14	United States	Malaysia	10
15	United States	Argentina	9
16	Germany	Korea	7
17	Japan	China	7
18	United States	Indonesia	7
19	United States	Thailand	7
20	United Kingdom	China	6

Note: Information for this table was drawn from the Joint Ventures and Strategic Alliances database, Thomson Financial Inc. Each entry shows the number (not the value) of licensing deals between firms from the different country pairs.

Source: Park and Lippoldt (2005)

Box 4. Role of intellectual property in promoting technology transfer through trade

The increasing importance of the technology aspect of trade has led to the introduction of intellectual property rights (IPR) in trade rules (i.e. the TRIPs Agreement). IPR protection promotes innovation by creating an artificial monopoly and providing a greater incentive for innovation than is otherwise the case. IPR protection is considered necessary because the supply of innovation may be suboptimal as innovation may yield lower private returns than social returns when imitation is freely allowed. IPR also facilitates the dissemination of technology by creating a market for technology to be

bought and sold. It is worth noting however that strong IPR protection is not an end in itself. Too strong IPR protection can create a monopoly situation inimical to dissemination of innovation and further innovation which build on these innovations.

As stated in Article 7 of the TRIPs agreement, the objective of TRIPs is to provide for “the protection and enforcement of intellectual property rights” so that they “contribute to the **promotion of technological innovation** and to the **transfer and dissemination of technology**, to the mutual advantage of producers and users of technological knowledge and in a manner conducive to social and economic welfare, and to a balance of rights and obligations.” It was considered necessary to close the cross-country gaps in terms of intellectual property protection, as the proliferation of products from countries who neglected IPR may lead to a reduction of the incentives for innovation in countries that have IPR systems in place. It was also considered that technology transfer from developed countries to developing countries may be promoted if technology receiving countries put in place intellectual property protection.

There has been criticism in development circles that the current multilateral rules on IPR tend to benefit technology leaders rather than followers, and that under the TRIPs agreement, developing countries will no longer be able to learn and to appropriate technology through such methods as reverse engineering which were available to some developing countries in the past. It should be noted that reverse engineering continues to be an important source of learning from many companies, and companies often engineer products “around” existing patents.

It is true that the setting up of IPR systems requires considerable resources, and that there may be significant differences between countries as to the desirable level of IPR protection. However, some of the criticisms such as the assertion that strengthening of IP protection in economies that are rapidly catching up may even create negative externalities in LDCs (UNCTAD, 2007) may be overstated, especially as licensing payments by LDCs have not been substantial. On the other hand, there is growing evidence that countries with robust IPR systems have benefited from greater technology transfer.³² Analysing a firm-level data set of US companies, Park and Lippoldt (2005) finds that strengthening of IPR protection had a net positive effect on international licensing of technologies between unaffiliated parties during the 1990s. Analysing royalty payments from affiliates to parents for US companies, Branstetter *et al.* (2006) find similar results for technological transfers from multinational parents to affiliates. Park and Lippoldt (2007) find by analyzing a large country data set in the period 1990-2005 that stronger levels of patent protection are positively associated with inflows of high-tech products, expenditure on R&D, and patent applications, which indicate that technology transfer is larger into countries with stronger IPR protection.

(4) *Investment and diffusion of innovation*

The role of FDI in diffusion

35. Foreign Direct Investment (FDI) also plays a key role in technology transfer and the diffusion of innovation.³³ While traditionally trade, licensing and investment were considered as alternative ways of exploiting technology in foreign markets,³⁴ they are becoming increasingly complementary, which has led to an explosion of FDI as well as trade. While there were 7,000 multinational enterprises at the beginning of the 1970s, today that number is closer to 70,000 each with, on average, ten foreign affiliates (OECD, 2006d). In line with the deepening process of globalisation, the stock of outward FDI relative to GDP among OECD countries for which the data are available has reached a level nearly quadruple what it was in the early 1970s (*ibid.*).

³² Park and Lippoldt (2005) describes how licensing agreements can be structured and provides a more detailed literature review.

33. See for example OECD (2002), OECD(2006d), OECD(2006e) and OECD(2007e) for more detailed discussions on the role of FDI in technology transfer.

34. In this view, firms first exported to foreign markets, which were subsequently replaced by FDI as foreign markets matured. In such a case exports would decline as sales were replaced by affiliate sales. Licensing was considered a way of entering markets when firms wanted to reap benefits from technology without paying the costs of entering these markets through exports or investment.

36. A growing literature³⁵ has found that multinationals and their affiliates are more productive and generate more ideas than their purely domestic counterparts. Bigger firms are generally more likely to adopt new technology than smaller firms³⁶ as they have access to more resources: multinational firms tend to be bigger and grow faster than purely domestic firms. However, there is growing evidence that multinational companies tend to innovate more than purely domestic companies even controlled for size. While the difference in productivity can be due to self selection,³⁷ this difference seems to be due to MNE's better access to assets that are not available in one location, such as technologies, market and employment opportunities, capital and management skills (Barba Navaretti and Venables 2004). There is also a growing acknowledgement that internationalisation of production can be a means to gain access to external knowledge sources that are complementary to the specific assets a firm is already endowed with. There is also some evidence that MNEs controlling production activities abroad generally outperform firms controlling non-production facilities only and this may point to the possible existence of "learning by investing" effects.

37. Multinationals can affect the performance of an economy in multiple ways. First, innovation and average productivity will increase as firms become multinationals or their affiliates. From this point of view, joint-ventures have been an oft-used way of technology transfer (See Box 5). It should be noted that the extent of technology transfer from the MNE to the local partner will depend greatly. Secondly, if the share of multinationals and affiliates increase in the economy, this will also increase innovation and average productivity in the general economy. Thirdly, there can also be an indirect effect, when there are spill-overs to other purely domestic companies through enhanced competition, imitation and demonstration, worker mobility and spin-offs, backward and forward linkages.³⁸ One finding of OECD (2001) was that "backward vertical linkages" from foreign owned enterprises are a particular potent source of spillovers, as domestic suppliers upgrade their production processes, quality and delivery methods in response to the demands of an internationally competitive client (See Box 5 and Box 13 on Moving up the global value chain).

38. "Given appropriate host-country policies and a basic level of development, a preponderance of studies shows that FDI triggers technology spillovers, assists human capital formation, contributes to international trade integration, helps create a more competitive business environment and enhances enterprise development (OECD, 2002)". MNEs thus can act as "bridging institutions" connecting geographically disbursed economic and innovation systems (Castellani and Zanfei, 2006). However, these externalities are by no means automatic: it depends on host-country policies and absorption capacities on the part of domestic firms, and in most cases domestic firms may need to bear extra costs to gain such externalities.

35. See for example Criscuolo et al. (2005). See also Doms and Jensen (1998) for the US, Barba Navaretti and Castellani (2004) for Italy, Criscuolo and Martin (2003) for the UK, De Backer and Sleuwaegen (2003a) for Belgium, and Pfaffermayer and Balek (2002) for Austria (Castellani and Zanfei, 2006 page 77).

36. For example, Alameida and Fernandes (2006) find that medium and large firms are 13 and 18 percentage points more likely to adopt technology than micro firms, respectively. Data on US patenting by industry in 1985-1990 finds that large firms are responsible for more patenting in many sectors such as photography (80%), semiconductors (77%), chemicals (73%), road vehicles (65%), telecommunications (57%) while accounting for less in others such as aircraft (48%), dentistry and surgery (19%), and textiles, clothing, leather and wood products (10%) [Table 2.4 in Stoneman (1995)].

37. The theory of multi-national enterprises find that they must have some exclusive, proprietary asset, such as a technology or better managerial ability, to compete and profit from the existence of an overseas production facility.

38. Work is currently being undertaken in the Trade and Agriculture Directorate to look at the extent of FDI spill-overs and preliminary analysis finds that (1) trade liberalisation is associated with stronger FDI spill-overs and higher productivity, and (2) encouraging foreign presence in the services sectors can have strong positive productivity effects in the economy [TAD/TC/WP(2008)7].

Box 5. Role of FDI in diffusion of innovation – the case of Sri Lankan garments and South African wine

(Sri Lankan garments)

The roots of the current Sri Lankan garments industry lie in MFA quota hopping FDI, which was subsequently emulated by domestic entrepreneurs. In addition, FDI has often been the driver of product innovation. For example, value added garments, or garments with buttons etc. were not produced in Sri Lanka until Sterling Lanka (a subsidiary of a Hong Kong MNE) started producing them locally for the export market. Installation of one of the world's most modern automated dye dispensing systems by Textured Jersey and the manufacturing of non-woven fabrics to produce interlinings for ladies' and men's wear by French based Intissel are examples where FDI have introduced the production of new products. Sri Lankan companies such as MAS holdings and Brandix Lanka have both extensively used joint ventures with technological leaders (e.g. with companies in the UK, China, France, Germany, Spain, Hong Kong and US) in order to begin production of new products and to obtain the required technology and expertise for the production of various fabrics, accessories and components such as bra cups, lace and elastics required as inputs for the production of intimates and casual/sports wear.

Source : TAD/TC/WP(2008)6/PART2/C

(South African wines)

The South African wine industry abounds with numerous examples where foreign buyers have acquired some of the most venerable estates (e.g. Hazendal (Russian investor), Blaauwklippen (German investor), Morgenhof (French investor), and L'Avenir (French investor)). These investments have involved considerable new financing and in some cases technology transfer. It is generally considered that these investments offer a synergistic relationship between wine production, overseas marketing and, as many are developing on-farm restaurants, the lucrative South African tourism sector and its overseas marketing.

Source : TAD/TC/WP(2008)6/PART2/D

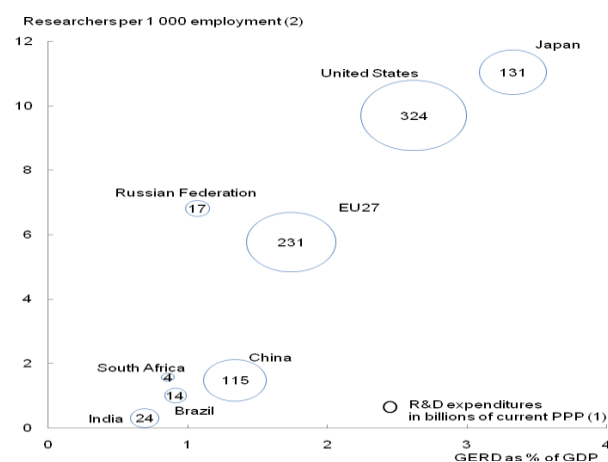
Internationalisation of R&D

39. Research and development (R&D) which had mainly been conducted in OECD countries have become increasingly internationalised with the increase in trade and investment. There are four interrelated aspects to the internationalisation of R&D: (1) **increasing presence of non-OECD countries** in the global R&D scene, (2) increasing presence of **non-OECD MNEs** in global R&D, (3) the increasing **internationalisation of MNEs R&D activities**, and (4) increase in **international alliances**.

40. OECD countries continue to conduct the lion's share of global R&D activities, and gross expenditure for R&D (GERD) as a percentage of GDP and the number of researcher per 1000 employment remain higher in OECD countries (Figure 7). However, R&D activities in non-OECD countries are becoming more important, and the combined R&D expenditure of China, Israel, Russia and South Africa was equivalent to almost 17% of that of OECD countries in 2004 up from 7% in 1995 (OECD, 2006c) and R&D expenditure in some non-OECD countries is growing faster than in OECD countries (See Table 5). There has also been an **increase of developing country firms setting up R&D units abroad** (UNCTAD, 2005) and developing country companies are increasingly using mergers and acquisitions to access R&D capabilities (e.g. acquisition of Arcelor by Mittal steel, IBM's personal computer business by Lenovo, among others).³⁹

39. For firms from developing countries, "investing in one of the three leading world innovators (the US, Japan or Germany) seems to be the single most important source of knowledge flows for these investing countries" (Al Azzawi cited in DAF/INV/WD(2006)15/REV2) .

Figure 7. R&D in the OECD and the non-OECD area



(Source: STI Scoreboard 2007)

Table 5. Evolution of Gross Expenditure for R&D (GERD) for selected non-OECD economies

	Annual average growth rate 1995-2000	Annual average growth rate 2000-2005
Brazil	5.2	-0.3
OECD	4.9	2.3
Argentina	3.1	3.0
India	9.9	3.8
Russian Fed.	6.0	6.5
Chinese Taipei	8.6	8.3
South Africa	7.8	9.5
China	16.4	18.5

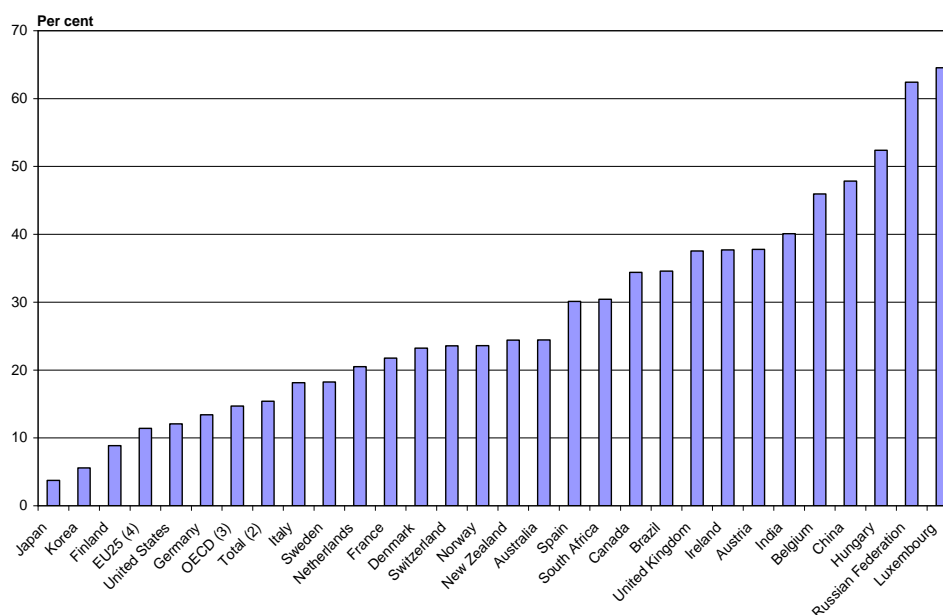
Source : STI Scoreboard 2007

41. Although R&D has traditionally been the least internationalised of MNE activities, and past studies looking at patenting activities of MNEs find that MNEs tend to have a home-bias,⁴⁰ there are increasing signs that MNEs are conducting R&D activities abroad. There is also an increasing emphasis on cross-border alliances in order to achieve technology development efficiently (see Box 6).

42. Internationalisation of R&D has evoked different concerns in different countries. In the majority of developed countries, the main concern is the possible erosion of home based R&D by “delocalisation” of R&D to developing countries that could result in a reduced capacity to absorb knowledge and technologies developed abroad, decrease downstream business activities, and reduce national influence on business decision making.⁴¹ OECD data shows that there is considerable heterogeneity in foreign ownership of domestic patents (See Figure 8). In catching-up economies that are strong attractors of R&D intensive FDI, the main concern is that foreign-owned R&D facilities may not contribute enough to the development of domestic innovation capabilities while absorbing a disproportionate share of the best human resources. The majority of less developed countries but also some OECD countries fear the risk of being altogether marginalised in the process of R&D globalisation.

40. See for example Patel and Pavitt (1990) and Di Minin (2005)

41. See Ernst (2006) for an example of a paper looking at the possible effect of “innovation offshoring” from the U.S. to Asia.

Figure 8. Foreign ownership of domestic inventions varies widely across countries¹

1. Patent applications filed at the European Patent Office, 1999-2001
2. All EPO patents that involve international cooperation.
3. Patents of OECD residents that involve international cooperation
4. The EU is treated as one country; intra EU cooperation has been netted out.

(Source:OECD, 2000c)

43. While there has been an increase of non-OECD patenting activity and internationalisation of R&D activity by MNEs, the effects on OECD R&D remain modest. The internationalization of R&D with more countries engaged in R&D, which is a high value added activity, could be beneficial to countries who are recipients of R&D related FDI, although the extent of the spill-over effect is not clear. The lowering of R&D costs through **internationalisation of R&D** could mean that MNEs can undertake more innovation projects, which could lead to higher rates of global innovation. For example, in the case of software, software engineers in India are said to cost a fraction of similar engineers in the U.S.⁴² To the extent R&D by MNEs gravitate towards countries with a conducive environment for R&D, governments need to consider policies to facilitate R&D such as education, policies to facilitate agglomerations and perhaps R&D tax incentives.

Box 6. Internationalisation of R&D activities by MNEs

The internationalization of R&D by MNEs is one key dimension of how globalisation is affecting innovation. MNEs traditionally used R&D facilities abroad to adapt technology developed in the home country to local markets (which is termed as **“home-base exploiting” or “asset-exploiting” R&D**). Some MNEs also opened R&D centres as a way to **monitor development abroad**. Recently however there has been an increasing tendency to set up R&D facilities with the objective of utilising the foreign pool of research talent (also termed as **“home-base augmenting” or “asset seeking” R&D**).⁴³ The growing R&D potential of large developing economies, the progress of ICT technologies and

42. The cost of employing a chip design engineer in Asia is typically between 10 and 20 percent of the cost of employing a design engineer in Silicon Valley (Ernst, 2006).

43. The U.S. Committee on Science and Technology raises the following examples: Accenture’s CEO announced that it will have more employees in India than the U.S. by August, 2007; IBM is projected to

the increased circulation of human resources in science and technology (OECD, 2006c) have led to this widening and deepening of internationalisation of MNE's R&D activities. The share of R&D performed by foreign affiliates has increased as multinational enterprises have acquired foreign firms and established new R&D facilities outside of their home country (OECD, 2006c).

Samsung, a leading Korean manufacturer of ICT products with 10 overseas research facilities around the world provides an illustration of how leading MNEs are globalising its R&D centers. Samsung started by setting up a facility in Silicon Valley in 1988, followed by one in London in 1991, and two facilities in Dallas and Yokohama in 1997. These research facilities are typical examples of R&D facilities set up to monitor technology developments abroad. More interestingly, the company has rapidly expanded its global network of research centers with the objective of utilising the foreign pool of research talent starting with Russia (1993), India (1996) and three recently added research centers in China focusing on semiconductor, mobile telecommunications, and electronics. Samsung has also seriously increased the size and capabilities of these foreign research centers. For example, Samsung's research facility in Bangalore which had no Ph.D. and 17 Masters, and 37 Bachelors in 2001, now hires 4 Ph.D.'s, 179 Masters, and 164 Bachelors.

International alliances have also increased due to various factors such as the rising cost of research, increasing technological convergence between products and increased need for speed. The rising cost of research related to new product areas has meant that even a global leader cannot cover all the costs itself. The increasing technological convergence between sectors (e.g. computers and automobiles to produce smart cars) and increased need for speed in response to rising competition has spurred the demand for technological alliances. Alliances are more flexible than cross-border mergers and acquisitions and offer a quicker way to build competencies than greenfield investment. On the supply side, improvements in information and communication network technologies have reduced the cost of co-ordinating, monitoring and enforcing alliances.

Source : Based on OECD (2006c) and DSTI/STP/TIP(2006)11. Reference to Samsung from TAD/TC/WP(2008)6/PART2/E

(5) *Limitations to trade and FDI as a conduit for technology transfer – absorption capacity*⁴⁴

44. The import of capital goods and intermediate products and/or investment can lead to technology transfer but it is not a sufficient condition for technology transfer to actually take place. Even if technology is transmitted, **absorption capacity**⁴⁵ is necessary for technology to be effectively transferred. Several studies have found that human capital is important for absorption capacity. For example, Borensztein et al. (1995) found analysing FDI flows from industrial countries to 69 developing countries that FDI is more productive than domestic investment only when the host country has a minimum threshold stock of human capital (when the average adult male has at least 0.45 years of secondary school education). UNCTAD (1999) conducts a similar analysis on the relationship of FDI and growth in developing countries and also concludes that while it is difficult to isolate the importance of different elements affecting growth, “the combination of FDI and schooling” have a positive effect on growth.

45. At the firm or organization level, absorption capacity will depend not only on the absorption capacities of its individual members, but also on absorption capacity as an organisation, which is not the simple sum of the absorption capacity of its employees. Absorption capacity of an organisation depends not only on the capacity to acquire information but also on the organisation's ability to diffuse the information within the organisation and exploit it. Thus the structure of communication between the external environment and the organisation, as well as among the subunits of the organization is of great

have 100,000 workers in India by 2010, more than one-quarter of its worldwide workforce; companies like General Electric, Eli Lilly, Google, and Microsoft are expanding R&D centres in India and China.

44. This section draws on Cohen and Levinthal (1990).

45. Absorption capacity can be defined as “the ability of a firm to recognise the value of new external information, assimilate it, and apply it” (Cohen and Levinthal, 1990).

importance for absorption capacity.⁴⁶ In a similar manner, **at the economy level, absorption capacity will depend on both the absorption capacity at the firm level, and the ability to share information within the economy.**

46. A firm's ability to understand external knowledge is often generated as a by-product of its R&D. Thus R&D not only generates new knowledge but also contributes to the firm's absorption capacity, often referred to as the dual role of R&D. OECD studies have found that this can be confirmed on a national basis as well. R&D tends to increase the extent to which a country can benefit from R&D spill-overs from R&D conducted in other countries. Prior related knowledge is important for absorption capacity, and this implies that accumulation of knowledge over time is important. Diversification of the economy would also be important if prior related knowledge for efficient absorption of new technologies. Several studies have shown that countries tend to diversify as they develop, after which they specialise.⁴⁷ As small countries cannot achieve minimum economies of scale in certain activities and diversify without exports and/or investment, this also would point to the importance of trade and investment in innovation.

47. Another important point is that recognition and assimilation of knowledge is not sufficient and that knowledge must be applied. As such, external factors such as macroeconomic stability, political stability, basic infrastructure such as telecommunication, electricity, transportation, supply of capital are also extremely important factors which affect "absorption capacity" in a broader sense (See Box 7). This is illustrated well in Figure 9 taken from World Bank (2008a).

48. In summary, when interpreting the above in terms of "absorption capacity" at a country level and implications for trade policy, (1) outside sources of knowledge including through trade and investment, is important for innovation, (2) however the contribution to domestic innovation will depend on "absorption capacity", (3) as technology is to a certain extent path dependent, import of technology in areas for which countries have some existing prior knowledge may be more amenable to absorption and domestic innovation, (4) as diversity of background is important for absorption capacity, diversification of production and exports can contribute to an environment more conducive to domestic innovation.

Box 7. Absorption Capacity – Comparison of the Agro-food sector in New Zealand and South Africa

Both New Zealand and South Africa have undergone extensive agricultural reforms and trade liberalisation but have led to quite differing outcomes. In New Zealand, substantial agricultural and trade reform led to a large increase in overall agricultural production and total factor productivity, and a large change in the composition of the sector. The dairy, deer, fruit and wine production have replaced the traditional sheep and beef sectors. Even in the sheep sector, despite the sharp decrease in the sheep flock from 70 million in 1983-4 to 40 million in 2004-5, the shift in focus from quantity to quality, and increase in processing have led to better results. In 2002, export revenues from a sharply reduced flock exceeded those generated by the 70 million strong flock in the early 1980s. In short, reforms and trade liberalisation have led to an across the board increase in innovation and productivity change in the sector.

The situation in South Africa is somewhat different compared to New Zealand. Reforms and trade liberalisation have indeed led to some innovative responses. There has been a big shift in the composition of production from field crops to horticultural products, with horticultural production, fruits and wines showing exceptional growth, mainly driven by exports. In the wine sector, there has been (1) numerous new entries, (2) increase in FDI taking advantage of synergies between wine production, overseas marketing and tourism, (3) large scale replanting and upgrading of vineyards, and (4) more active industry cooperation. In the fruit sector such as grapes and oranges, production and exports have increased through (1) the addition of new production regions, (2) introduction of new production technology and (3) introduction of temperature controlled special containers. In the field crop sector, in response to lower prices,

46. One interesting point is that critical knowledge does not simply include substantive, technical knowledge; it also includes awareness of where useful complementary expertise resides within and outside the organisation.

47. Imbs and Wacziarg (2003) for example shows that countries first diversify in the sense that economic activity becomes spread more equally across sectors, but that there exists relatively late in the development process a point at which they start specialising again.

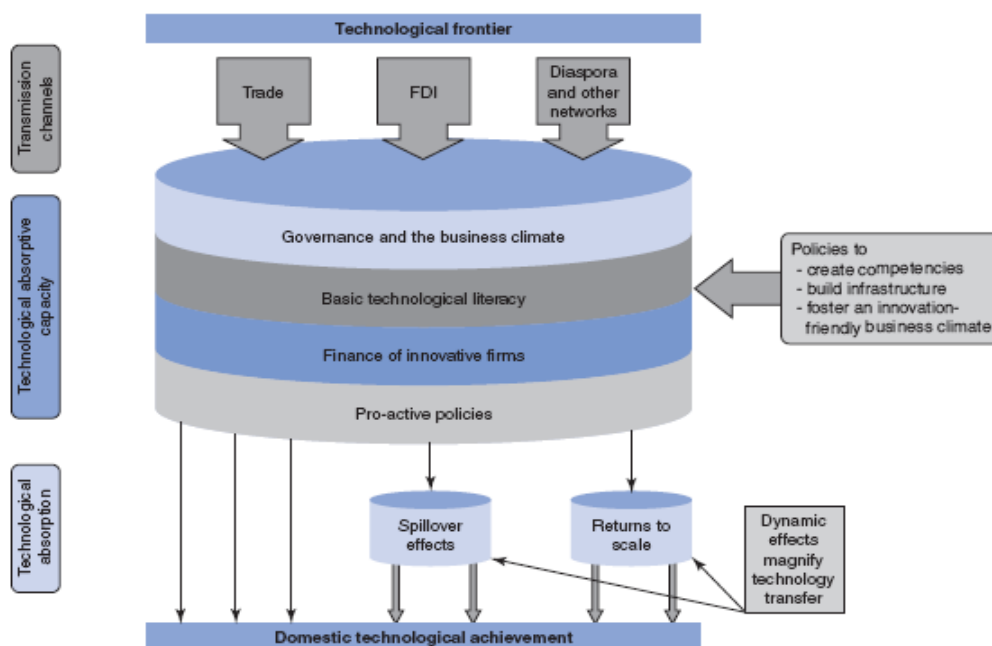
farmers have shifted to minimum and low-tillage production systems, and reduced the use of inputs such as fertilisers, insecticides and herbicides, tractors and other machinery, and of fuel in crop production (i.e. there has been little innovation and/or use of technology to improve productivity apart from greater adoption of GM technology).

Innovation however has been rather limited in some sectors in South Africa, especially those which are characterised by subsistence farming. While it is true that South Africa is less exposed to international markets by virtue of its 'natural protection' in the form of high infrastructure costs and relatively large domestic market, absorption capacity in a broad sense seems to have been the main reason for the lack of innovation response. Although more than a decade after the introduction of the new 'Rainbow Nation', fewer than 2,500 farmers (6.6% of the commercial farmers) still account for more than 50% of the total gross farming income, which shows the duality of this sector with large scale commercial farmers on the one hand and a numerically dominant semi-subsistence element on the other. As semi-subsistence farmers neither have the resources (financially or otherwise) or the ability to bear risk, technological progress has been inhibited in this subsector. More puzzling is the relatively low innovation levels in the commercial farming sector. One reason is that the introduction of new technologies is often at odds with the policy of trying to decrease rural unemployment and thus poverty. Another is that the possible risks of land redistribution, as happened in Zimbabwe, lessens the incentives to make large investments in the land. Shortcomings in terms of transport infrastructure, electricity, also inhibit "absorption capacity." South Africa continues to face the challenge of increasing absorption capacity, innovation and growth while trying to balance this with equity considerations.

Source : Based on TAD/TC/WP(2008)6/PART2/D

49. While path dependency is bad news for developing countries trying to catch up, there are some views that the lack of existing infrastructure and technology can be an advantage. Existing enterprises and users who have vested infrastructural investments in existing technology can resist major innovations, and act as a barrier to the introduction of new technologies. Lack of vested interest in existing technology may allow countries to take advantage of new technologies through **leapfrogging**, or the deployment of advanced technologies in developing countries ahead of their deployment in developed countries. The most cited example of this is the diffusion of mobile telephony in the absence of fixed line networks, and the diffusion of decentralised electric power units in the absence of centralised electricity networks. Banking services using mobile phones are starting to be used by about half a million users in South Africa mainly because there is a high demand for cheap and convenient ways to send money while only a fraction of people have a bank account (Economist, Oct 26th, 2006). Another example can be found in the petrochemical industry, where a large number of the most up to date, large scale plants can be found in developing countries in the Middle East and South East Asian countries.

Figure 9. Stylised presentation of absorption capacity



Source : World Bank (2008a), Figure 8

(6) Competition effects of trade and investment on innovation

50. **Trade affects innovation through competition.**⁴⁸ Tariffs, non-tariff barriers such as different standards can shield domestic industry from competition and lead to an increase in mark-ups or rents. Increased competition through imports has a disciplining effect on domestic industries. Studies looking at the changes in mark-ups when countries liberalise trade find a negative relationship between trade openness and mark-ups for imperfectly competitive markets: pressure from competing imports lead to a decrease in rents.⁴⁹

51. FDI can have a similar disciplining effect although this greatly depends on the underlying motivations and the method of investment, and on the characteristics of the host economy. If the FDI is “tariff hopping” / rent seeking FDI, in the form of an acquisition (with no new entry), and in a small and closed (therefore less-competitive) economy, FDI will have minimal disciplining effect. If the FDI is market seeking or efficiency seeking FDI in the form of a Greenfield investment (new entry) and in a large or open economy, FDI can have a stronger disciplining effect. The effect of FDI can be stronger than imports as foreign companies have access to local inputs and information that imports cannot utilise.

52. In an increasingly globalised economy, not only imports and inward FDI affect innovation through competition. For companies which export, have outward FDI, or who sell to exporters, changes in foreign markets can have competition effects even in the absence of imports or inward FDI.⁵⁰ (See Box 8). When looking at the role of trade and investment in innovation, it is necessary to take into account such indirect affects as well.

Box 8. Role of competition on Innovation

(Example of Intel, United States)

Founded in 1968, Intel Corporation is the largest semiconductor manufacturer in the world. From its beginnings, it has been at the forefront of various innovations in the semiconductor industry. For example it was the company to produce the world's first microprocessor the Intel 4004. Interestingly, the first microprocessor was a byproduct of efforts to develop another technology – a request to design cost-effective chips for a series of calculators by a Japanese calculator manufacturer, Busicom. During the 1970s, Intel continued to improve its microprocessors and develop new products such as the erasable programmable read-only memory (EPROM). In 1983 sales reached \$1 billion for the first time. However, during the early 1980s, Intel began to slip in some of its markets as highly efficient Japanese and other increasingly innovative competitors challenged Intel's position. Fierce competition in DRAMs, static RAMs, and EPROMs left Intel concentrating on microprocessors. This focusing strategy succeeded and in 1982 Intel introduced its 80286 microprocessor, which came to dominate the upper-end PC market, followed by the 386 chip in 1985, the 486 in 1989, and the Pentium in 1993.

(Example of the Sri Lankan garment industry)

The Sri Lankan garment industry which had grown rapidly by virtue of quotas under the Multi-Fibre Agreement was faced with intensified competition in its export markets from lower cost producers from China and India by the gradual phasing out of the MFA until 2005. In response, the Sri Lankan industry formed the Joint Apparel Association Forum (JAAF) in 2002 which has facilitated intra-industry technology transfers and enabled an industry wide response

48. Past work in OECD on trade and competition have found a strong relationship between trade and competition and includes “Core principles in trade and competition context” (2002); “Trade, competition and intellectual property rights” (2000); “The impact of pro-competitive reforms on trade in developing countries” (2006); and more recently “The interaction amongst trade, investment and competition policies” (Bartok and Miroudot, 2007). The first paragraphs of this section draw on Bartok and Miroudot (2007).
49. See for example Levinsohn (1993) and Roberts and Tybout (1996) which have found such results at the firm level for different countries (Turkey, Mexico, Colombia, Chile and Morocco), different time periods and different sectors.
50. Not only actual, but also potential competition affects innovation. See for example, Kamien and Schwartz (1975).

to various challenges. The domestic industry has spurred innovation of various forms including marketing innovations (international image building such as “Garments without Guilt”), product innovations (new product design and development, organic and fair-trade garments), process innovations (introduction of productivity improvement programmes, CAD/CAM technology, enterprise resource planning (ERP) systems, Green Manufacturing), and organizational innovations (new sourcing from India/Pakistan, FDI into India etc.).

(Example of Sagami elc, Japan)

Sagami elc is a manufacturer of switches for various uses. Their switch for mobile phones enables the screen of a foldable mobile phone to be switched off when it is folded and on when it is opened. Similar switches are used in notebook PCs and digital cameras. Competition has intensified as manufacturers have moved production facilities to low-labour cost countries. The interesting thing is that Sagami elc has resisted the trend where many parts manufacturers have invested abroad with their customers to benefit from lower labour costs. Although there have been no imports into Japan, pressure from China is strongly felt. A company spokesman states “if the production method and equipment can be adapted so that one person does the work of 10 people, it is more than possible to be successful with just a domestic factory”. While providing higher quality, it has remained price competitive by providing a wide variety of high quality switches (7000-8000) and continually innovating. The company has over 70 domestic patents and 13 international patents, and develops all manufacturing equipment by itself. Rather than complete automation, it designs simple, light equipment that can be used with minimal human involvement to maintain flexibility and leaving room for productivity improvement while minimizing capital investment. Used and depreciated equipment is often used as a basis for further improved equipment to minimise capital expenditure.

The above examples show how trade can be a strong driver of innovation. Intel’s case shows how foreign competitors have forced a company to refocus its business and innovate out of competition. The example of the Sri Lankan garment industry shows how increased competition in export markets can affect innovation. Sagami’s example shows that even when there are no imports, an increase in global competition at the customer level can have a similar effect on innovation.

Source : Based on company website for Intel; TAD/TC/WP(2008)6/PART2/C for Sri Lankan garments; Kimura (2005) for Sagami

53. There are two opposing, but not necessarily contradicting, views on the effect of competition on innovation in the literature. Under the Schumpeterian view, rents are the main source of innovation for companies to conduct research and development. Under this view, erosion of profits through increased competition reduces a **company’s ability and incentive to innovate**. The opposing view is that greater competition increases **the incentives to improve performance** through innovation and reduction of slack⁵¹.

54. Empirical evidence has been mixed and neither of the one-dimensional views has been found to hold. Some studies have shown that industry innovation tends to decrease as the level of concentration rises.⁵² There is evidence that competition-restraining regulations slow the rate at which positive productivity shocks diffuse across borders and new technologies are incorporated into the production process. Estimates suggest that there can be a difference of up to 25% in productivity between countries, which can be as high as 40% in some sectors.⁵³ Cameron(2005) finds that Japanese industries that are more open catch up faster to their US counterparts. Scherer and Huh (1992) analyse a panel of US companies and find that there is considerable heterogeneity in R&D spending reactions to changes in high-technology imports. They find that on average R&D/sales ratios were reduced in the short run as imports rose, but

51. For example Baygan and Mann (1999) finds that R&D expenditures in sectors that are protected from global competition do not translate into higher labour productivity, whereas R&D expenditures in sectors facing global competition do enhance productivity both for high and low technology types of products (Baygan and Mann, 1999 as cited in Mann, 2006).

52. See for example, Blundell at al. (1995), and Acs and Audretsch (1988). Mohnen and ten Raa (2003, final 2008) analysed how the distribution of rents between capital and labour can affect innovation, and find that labour rent negatively affected performance while capital rents had a mild positive impact on performance mainly through R&D.

53. See Conway et al. (2006).

were more aggressive in the longer run. Insulation from import competition through trade barriers generally made companies' reactions more submissive.⁵⁴ The above evidence seems to support the hypothesis that lack of competition tend to slow the rate of innovation and its diffusion.

55. Recent empirical research is beginning to reveal that there may be considerable differences in the relationship between competition and innovation depending on the nature of the industry, existing levels of competition in the country, and existing levels of technology in the company. First, the importance of R&D is different according to industry. **R&D intensity is generally higher for industries closer to the technology frontier.**⁵⁵ There is some evidence that **levels of innovation fall more rapidly in response to less competition in industries closer to the technology frontier**, which implies that the costs in terms of innovation of having too little competition grows as the economy develops and gets closer to the frontier (Aghion, 2006).⁵⁶

56. Secondly, there is some evidence that the **relationship between competition and innovation** may be **an inverted U shape** (Aghion et al., 2006).⁵⁷ Lower levels of innovation can be observed at the lowest (pure monopoly) and at the highest levels of competition (perfect competition), while higher levels of innovation can be observed at moderate levels of competition. This would mean that competition can either enhance or reduce innovation depending on existing levels of competition. Third, the above study also finds that the entry of new competitive firms can have divergent effects on innovation of incumbents depending on incumbent's efficiency. Efficient firms would tend to increase their R&D as they have a possibility to maintain their dominant position, while inefficient firms that are further behind the technological frontier would tend to reduce investment in R&D as the possibility that they can successfully compete with the potential entrant and reap satisfactory returns to their investment are slim.⁵⁸

57. While the relationship between competition and innovation is far from clear, one may conclude that **trade and investment** as driving forces of global competition **can either stimulate or suppress innovation** depending on levels of technology and on the level of prevailing levels of competition. In particular, if a country/sector/company is at the technology frontier, increased competition through freer trade and investment is more likely to lead to an increase of innovation, especially if there is some consideration given to the possible lack of resources due to decreasing rents. Differences in standards between markets can also have large effects on the innovation process (Box 9).

58. In a small developing country with relatively low levels of existing competition, introduction of competition through trade and FDI is expected to enhance innovation. In such a situation, reduction of slack (efficiency effect) and the market share effect (weeding out of less productive companies) tend to

54. Insulation from import competition through trade barriers could theoretically lead to higher R&D spending as it increases rent available for R&D. However if these rents are simply redistributed to capital and labour, it will not lead to an increase in R&D and innovation.

55. Acemoglu, Aghion and Zilibotti (2006) cited in Aghion (2006).

56. The study also recommended that countries close to the technological frontier should invest more in higher education to promote development of cutting edge technology as well as proceed with structural reforms in the financial and labour markets.

57. Other authors have also emphasised the non-monotone nature of the relationship between innovation and competition (Boone, 2001). Inui et. al (2008) confirm such a relationship for the Japanese manufacturing industry.

58. Inui et al. (2008) studied the effect of new entry on incumbents and confirm such an effect (i.e. new entry encourages innovation when a firm's technology level is close to the technology frontier while it discourages innovation in firms far from the frontier) using microdata from the Japanese manufacturing industry.

have a much larger effect than the technical-change component (change in technology) of productivity growth.⁵⁹ However, if firms are too far behind the technological curve, entry of new firms at the technological curve on an equal footing may decrease innovation by incumbents. This could point to the importance of sequencing: countries with many companies which are far from the technological frontier may need to modulate competition from imports and FDI in order to solicit investment in R&D. Preannounced trade policy reform roadmaps may facilitate adjustment and act as a focussing device for innovation (Engman et al., 2006).

Box 9. Role of standards in competition and innovation

A standard is “an agreed way of doing something” or a specification designed to ensure that a material, product, method, or service is consistent. Standards have various benefits such as facilitating transactions by making it easier to discriminate quantity/quality, ensuring compatibility/interoperability, ensuring regulatory compliance and addressing various consumer safety and health concerns, among others. Standards also affect trade, as differences in standards between countries can become technical barriers to trade. Technical barriers between countries will effectively limit competition between countries. Standards also affect the innovation process and are an important part of the technical infrastructure for innovation. When well designed and appropriately timed, standards facilitate innovations and their equally important market penetration (Tasse, 2007). Standards focus innovation efforts, facilitate competition and ensure compatibility/interoperability. Inappropriate standards on the other hand can close off potential roads of innovation.

The example of Nokia and Samsung showed how standards can play an extremely powerful role in promoting innovation through competition. Whereas innovation in the telephone industry was relatively limited when markets were segmented, the unification of the telecommunication markets through unified standards first in the Nordic region and subsequently within the EU led to a larger market, triggering competition, innovation, and considerable growth. For a smaller country like Finland and Korea, the benefits of having a common standard with larger markets were quite evident.

Japan, Finland and Korea’s telecommunication equipment industry provides an interesting contrast. Although the electronics and telecommunication equipment industry was among the most competitive in the late 1980s and early 1990s, the Japanese industry failed to benefit from the global surge in telecommunication handset demand, mainly because of differences in telecommunication standards and the relative domestic focus of its industry which was enabled by its large domestic market.⁶⁰ The example of the Japanese telecommunication handset manufacturers provides an example of how size can be a mixed blessing which can preclude domestic manufacturers from achieving economies of scale when standards differ from the globally dominant standard. This example also suggests the increasing risk of setting domestic standards without sufficient international participation/involvement.

(7) *Benefits of exports (learning through exporting and economies of scale)*

59. Numerous studies have found that firms who export are more productive than those who do not. There are three alternative but not mutually exclusive explanations that exporting firms are more productive. First, exporters may self-select into export markets. It is widely acknowledged that there are fixed cost to exporting.⁶¹ In order to make the investment to pay these fixed costs, exporting firms by definition need to be more productive. The vast majority of studies support this explanation and find that “exporter premia” exist.

59. See Ten Raa (2007).

60. See Funk (2002) for details.

61. The range of extra costs include transportation costs, distribution and marketing costs, personnel with skills to manage foreign networks, or production costs in modifying current domestic products for foreign consumption (Alvarez et al., 2007).

60. The second explanation is that there may be a “learning by exporting” effect,⁶² or that exporters may become more productive by exporting for example by getting more access to technology, getting new ideas from customers and by being subject to stronger competition. The empirical evidence on “learning by exporting” is more ambiguous⁶³ with some studies finding such effects and others not. There is however a substantial amount of anecdotal evidence which point to the existence of “Learning-by-Exporting” whereby foreign customers provided information about product designs, materials, labeling, packaging and shipping, assistance to reduce costs and control quality, help in the factory layout, etc (Lopez, 2005). The New Zealand case study and Sri Lankan case studies also find that there seems to have been a “learning by exporting” effect (Box 10).

61. One reason that empirical analysis based on data has found it difficult to establish a learning by exporting effect is that firms often make deliberate decisions in terms of investment, training and technology to raise productivity in order to serve their export markets⁶⁴ before market entry, making it more difficult to pick up differences before and after the beginning of exports. There may also be considerable differences depending on the good or the destination market: some goods/markets may be more conducive to learning by exporting than others. In some industries there may be no learning by exporting at all.

Box 10. Learning by exporting – examples from New Zealand and Sri Lanka

The textile and clothing industry in Sri Lanka provides a typical example of how “learning by exporting” has worked. Starting out as contract manufacturers, major companies in the industry such as MAS Holdings and Brandix have improved their technological capabilities through their interactions with customers such as GAP, Marks & Spencers, Nike, etc. One recent example is MAS Holding’s initiative to introduce Green Manufacturing Plants which it is undertaking with the support of Marks & Spencers which is providing advice on sustainable construction through its store development experience and the creation of its “green” stores in the UK (see also Box 13).

The experience and growth of the New Zealand wine industry provides another good example. The industry was domestically focused before reforms, characterised by small scale family enterprises producing largely fortified wines for an unsophisticated and highly regulated, and largely uninterested domestic market. The removal of tariff protection and other forms of trade-distorting support together with a progressive reform of regulations led to increased competition and a renewed focus on export markets. This has induced consolidation which led to the growth of large producers and expansion in the number of new independent “boutique” producers of high quality specialised wines using innovative processes for production and marketing. For example, with a view to building high-value brands, some New Zealand wine producers are seeking to develop their credentials in terms of sustainability (e.g. Grove Mill Wine has used improvements in information technology to increase traceability, and other new technologies (cold cellaring, recycling water etc) to attain certification under the CarboNZero programme.

The experience of the Gallagher group in New Zealand provides another example. The Gallagher group up to the mid-1980s was a company making electric fences and farm gates for the domestic market. However, after reforms forced the company to enter the export market, it found an opportunity to use IT technology to develop its core products into innovative security services. By 2002-3, it had established distribution systems in more than 130 countries and was

62. See Lopez (2005) and Wagner (2007) for literature reviews of empirical studies that look at the relationship between exports and productivity.

63. Examples of studies which have found evidence of “learning-by-exports” include Bernard and Wagner (1997), Clerides *et al.* (1998), and Isgut and Fernandes (2007). On the other hand, a number of research projects do not find effects. For example, in a research project using comparable micro-level data for 14 countries, they found evidence in favour of learning-by-exporting for Italy only (Alvarez *et al.*, 2007). De Negri and Araujo (2007) support the view that exporting is related to international acquisition of technology. Through an analysis of 43,595 firms they find that national exporters are in general more innovative (48% compared to 36% for national non-exporters), and that innovative companies that export have a 40% more probability of acquiring technology abroad than innovative companies that do not export.

64. Hallward-Diermayer, Iarossi and Sokoloff (2002).

rapidly diversifying into other product lines – many of which were derived from the company's original product – electric fences.

Source: TAD/TC/WP(2008)6/PART2/C for Sri Lanka and TAD/TC/WP(2008)6/PART2/B for NZ

62. The third explanation why exporters are more productive is that **trade, especially exports, extend the size of the market** over which margins can be earned, providing greater incentives for increased investment in innovation. A large part of R&D costs are fixed (i.e. do not change depending on the sales quantity) so a company selling to both domestic and export markets may be able to recoup R&D investments over a larger sales quantity. These scale economies are especially important for countries with smaller domestic markets (Box 11). For example, Samsung, a leading ICT company in Korea spent 4.6 billion USD or 8.3% of total sales on R&D in 2004. Only about one sixth of the sales was domestic: if there were no exports and sales were limited to the domestic market, Samsung would need to spend nearly 50% of its sales to maintain such R&D levels. Van Biesebroeck (2005) looks at sub-Saharan firms and finds that exporting companies are more productive and that they increase their productivity advantage after entry into the export market. He estimates the effect of exporting on productivity to be between 25% and 28%, and find that scale economies are particularly important for small economies in sub-Saharan Africa.⁶⁵

Box 11. Role of scale economies through exports – New Zealand's Agriculture Sector and Finland's telecommunication equipment sector

For small economies, trade is a necessary and critical component of growth strategy. A small domestic market is often not sufficient to cover the research and development expenditure that is necessary to maintain levels of innovation and to compete in the global economy.

For example, New Zealand's agricultural sector depends heavily on international markets with some 90% of all pastoral production and more than 95% of dairy products manufactured in New Zealand exported. While domestic sources of innovation are important, imported technology has played a key role in the modernization of New Zealand's agriculture. New techniques in agri-technology, animal remedies (including genetics), software, agricultural tourism, machinery, and biochemical businesses, were rapidly absorbed and adapted from the mid-1980s, none of which were 'global firsts'. This adoption and absorption process has been enabled as the R&D costs can be funded through export sales and has also in part been driven by the need to be internationally competitive.

The above holds for another small economy like Finland. Nokia is the world's largest manufacturer of mobile telephone devices and Nokia Siemens Networks is number 2 in telecommunications infrastructure. Domestic sales constitute only 1% of its global sales. R&D expenditures as a share of sales was 11.2%, or \$3.8 billion USD in 2005. If Nokia had limited itself to the Finnish market, its R&D expenditure would have had to be cut by 99% or even if Nokia had limited its sales to the European market it would have had to be cut to a third.

The above examples of New Zealand and Finland show very well how exports can provide sufficient scale economies in addition to incentives for innovation, both in terms of creation of new technology and absorption of technology. It should be noted that innovation in export sectors has had important spill-overs to the wider economy as well. A major part of New Zealand's high value manufacturing and processing is, for instance, directly dependent on agribusiness, including state-of-the-art processing, packaging, agritech equipment, machinery and software (New Zealand Ministry of Agriculture and Forestry, 2003). Nokia's R&D in the telecommunication equipment sector has had considerable spill-overs in other parts of the economy such as services.

Source : Based on TAD/TC/WP(2008)6/PART2/B for NZ and TAD/TC/WP(2008)6/PART2/A for Finland

65 . The effect of simple economies of scale, and economies of related to investment in new technology/innovation may be difficult to distinguish.

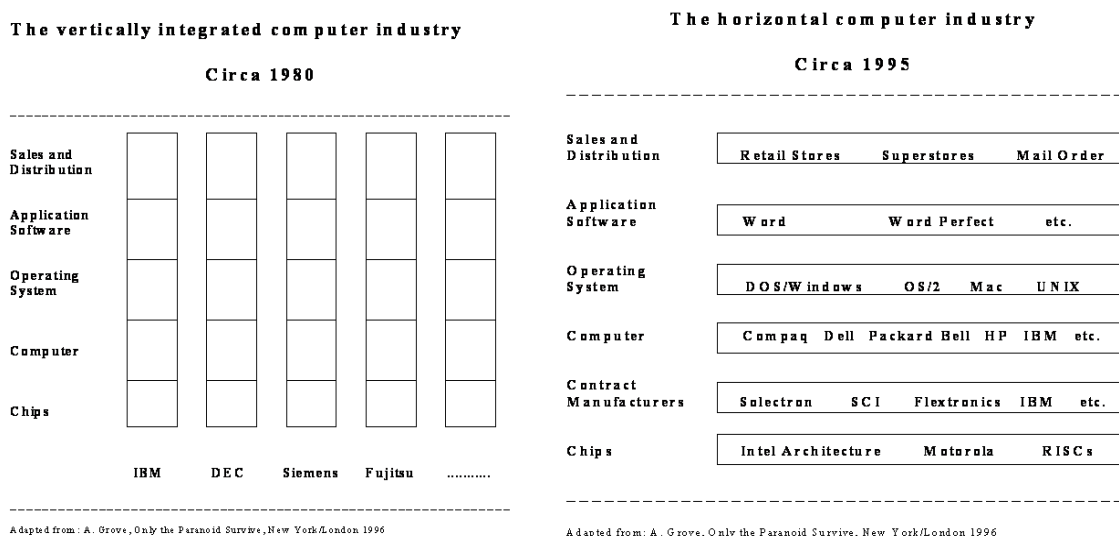
4. Production Networks and effects on innovation

(1) Global value chains and cross-border production networks

63. Advances in technologies in communications and logistics, and the decline of trade and investment barriers around the world have allowed production processes to be fragmented. The production process can now be divided into discrete tasks which can be conducted in either geographically concentrated locations or distant locations. This has led to the globalisation of value chains. **Globalisation of value chains is an innovation in its own right** as it is a **new organisational method in business practices**. **Multinational-enterprises have been the driver** of global value chains, and **trade and investment is a key enabler** of this new organisational method. The globalisation of value chains has been driven by a number of factors: search for efficiency, entry into new markets and access to strategic assets. The desirability of fragmentation will depend greatly on the nature of the industry, transportation costs, and communication costs among other factors.

64. One key driver of global value chains have been **changes in industrial structure**. Changes in industrial structure from vertically integrated structures to horizontal structures have facilitated the emergence of global value chains and the emergence of cross-border production networks (Figure 10). For example, computers around 1980 mainly consisted of mainframes where various parts of the computer such as chips, computer systems, and software were all developed in one company, and as such had a vertically integrated structure. However, with the advent of personal computers which have a modular structure, and where interfaces between modules are standardised, the computer industry has shifted to a horizontal structure which is more conducive to fragmentation of the production process. Other industries such as mobile phones have also followed similar paths, while some products such as automobiles still have a more integrated structure, and fragmentation has remained more limited up to now.⁶⁶

Figure 10. An example of a change in industrial structure – the computer industry



(Source: Luethje (2007) adapted from Grove (1996))

66. While more and more parts are being outsourced, the automobile companies such as GM, Toyota and Renault have a key role as integrator, while this is less the case with electronic products where the interface between different parts are more standardised.

65. Such a transition in the computer and electronics industry has opened the door to increases in contract manufacturing or electronics manufacturing services (Luthje, 2003).⁶⁷ **Contract manufacturers** are manufacturers who specialise in manufacturing products for brand name-firms (or OEMs). Six major contract manufacturers, Celectica, Flextronics, Jabil Circuit, Hon Hai Foxconn, Sanmina SCI and Solectron make various electronic products for a variety of brand names from mobile phones for Ericsson, Motorola, and Nokia to Ipods for Apple, and each employ between 50,000 and 200,000 employees globally and have sales between 8 billion USD to 16 billion USD (van Liemt, 2007). In 2005, the top 50 manufacturers exceeded \$100 billion in sales and recorded sales of 129.2 billion USD.⁶⁸

66. In the semiconductor industry, the emergence of companies specialising in the manufacturing of semiconductors (foundries) have opened the door to **fab-less design firms** who develop their own designs and contract with foundries to produce their wafers. The advent of contract manufacturers has allowed original equipment manufacturers like Hewlett Packard to focus on product development while contract manufacturers have been able to focus more on managing the production facilities. As competition has intensified both in terms of price and quality, there is an increasing emphasis on speed-to-market: getting the right product to the large, volume segment of the market on time can lead to huge profits while being late can be a disaster (Ernst, 2003). One key merit of this fables/contract manufacturing model is that manufacturing capacity can be rapidly added. Another key merit of this model is that **contract manufacturers can utilise manufacturing capacity more efficiently than integrated manufacturers**: the former can utilise its capacity as long as some of their customer's products are successful in the market place while the latter bears the full risk of idle capacity when its products are not successful. The contract manufacturer is better able to serve the global market as it can maintain manufacturing capacity in more locations.

(2) *Global value chains as observed in the data*

67. The **fragmentation of the production process** can be observed in several forms: trade in capital and intermediate goods, overseas investment of multinational enterprises, domestic outsourcing, and offshoring (international outsourcing or "trade in tasks"). While accurate data is not available, available data points to deepening of fragmentation.

Trade in capital and intermediate goods have been on the rise

68. Trade, both imports and exports, have grown much faster than GDP in many countries. Trade in capital and intermediate goods as a share of total trade has also been on the rise from the 1980s until the recent past (See Figure 11). Share of capital goods in total trade increased from 21.0% in 1970 to 26.5% in 2006. More significantly, Share of intermediate goods in total trade increased from 7.5% to 13.0%. While such a trend can be seen both in OECD and non-OECD countries, the increase is more pronounced in non-OECD countries in particular China and ASEAN.⁶⁹ It should be noted that because these classifications are based on product categories and not uses: thus while computers are in reality used both as capital and consumer goods, they are classified as capital goods.

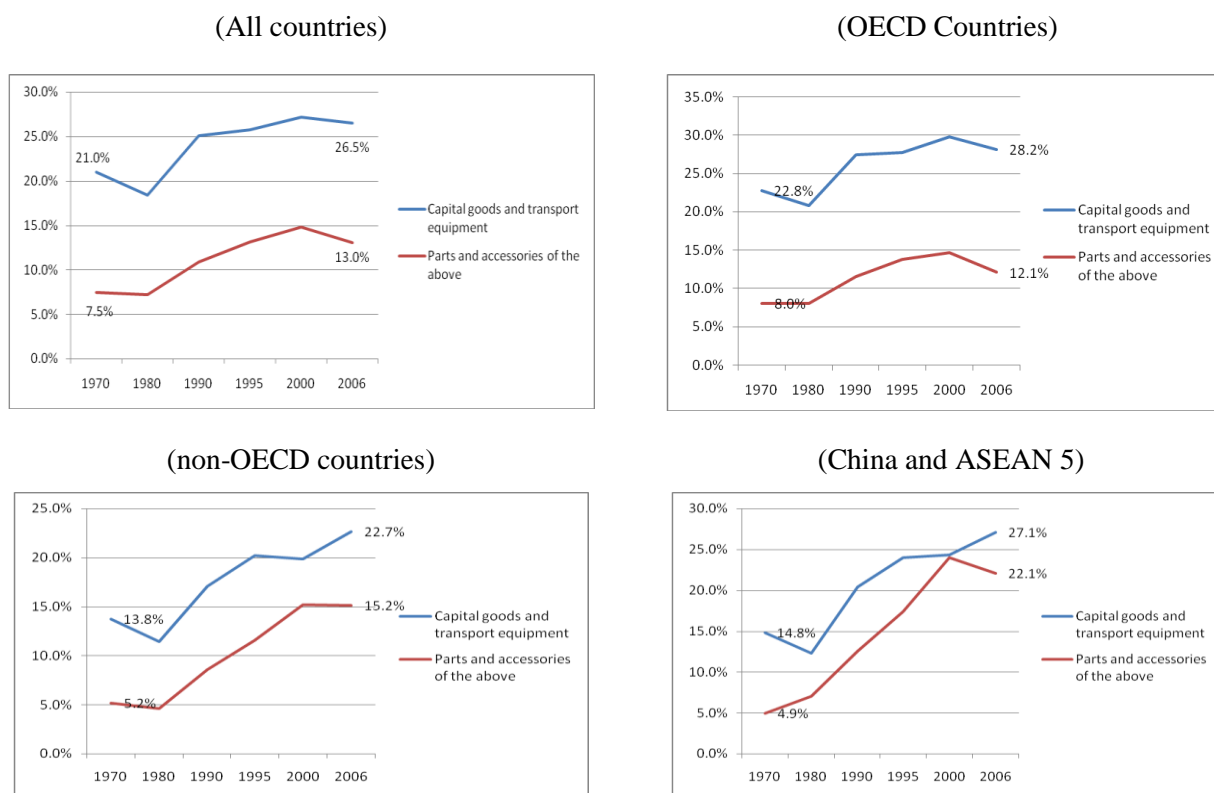
67. One of the keys to such a shift was standardisation of the key components. See Box 9 on standardisation.

68. Manufacturing Market Insider "Annual MMI Top 50 EMS Producer Rankings 2006"

69. See for example, Ando (2006) and Ando and Kimura (2007) for analysis and established facts on the production networks in East Asia. Ando finds that (1) intra-regional trade in East Asia expanded 6.7 times between 1981 and 2001 compared to 3.1 times globally, (2) the share of machinery in total trade rose in the 1990s, and (3) both exports and imports of machinery parts and components increased more rapidly, which suggest a pattern that would be typical of back-and forth transactions in vertical production networks.

69. The increasing trade of intermediate goods is reflected in the decrease of production depth (value added as a percentage of production) in many OECD countries (OECD, 2007a).⁷⁰ The ratio of imported intermediates to domestic intermediates has also increased between 1995 and 2000 in many OECD countries (Figure 12).^{71,72} The increase in import content of exports in many industries and countries provides further evidence of globalisation of the manufacturing process (Figure 13 and Figure 14).

Figure 11. Trade in capital and intermediate goods as a share of total goods trade (all countries)



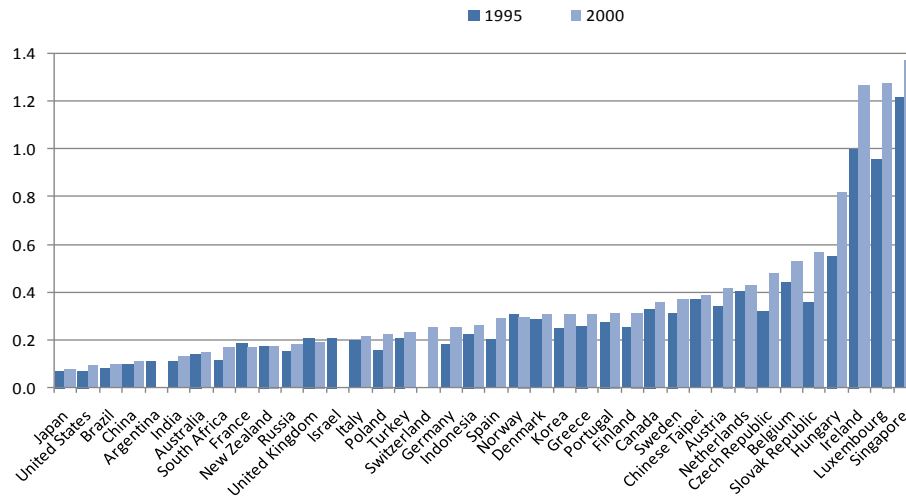
1. United Nations Broad Economic Categories. Capital goods and transport equipment include categories 41, 51 and 52. Intermediate goods only include categories 42 and 53, and excludes food and beverages, industrial supplies and lubricants which are often included in intermediate goods.

Source : Secretariat using UN COMTRADE

70. Figure 2.7 in OECD(2007a).

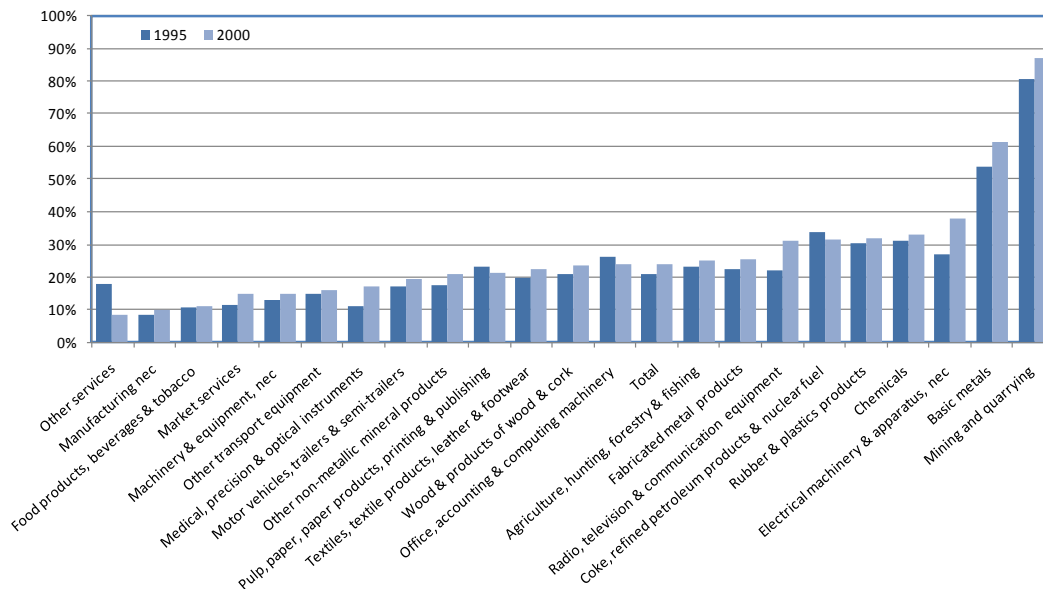
71. Figure 2.11 in OECD (2007a) from input output tables in OECD countries. The ratio of imported intermediates to domestic intermediates range from as high as 80% in smaller countries such as Hungary to below 10% for larger countries such as Japan and the United States.

72.. Trade in intermediate products as a share of intra regional trade in Asia increased from 42% in 1980 to 60% in 2005, while in the same period, there was little or no change at 46%-50% both in the EU25 and NAFTA areas (METI, 2007). This may point to considerable regional differences in this phenomenon.

Figure 12. Imported/domestic intermediates, 1995¹ and 2000²

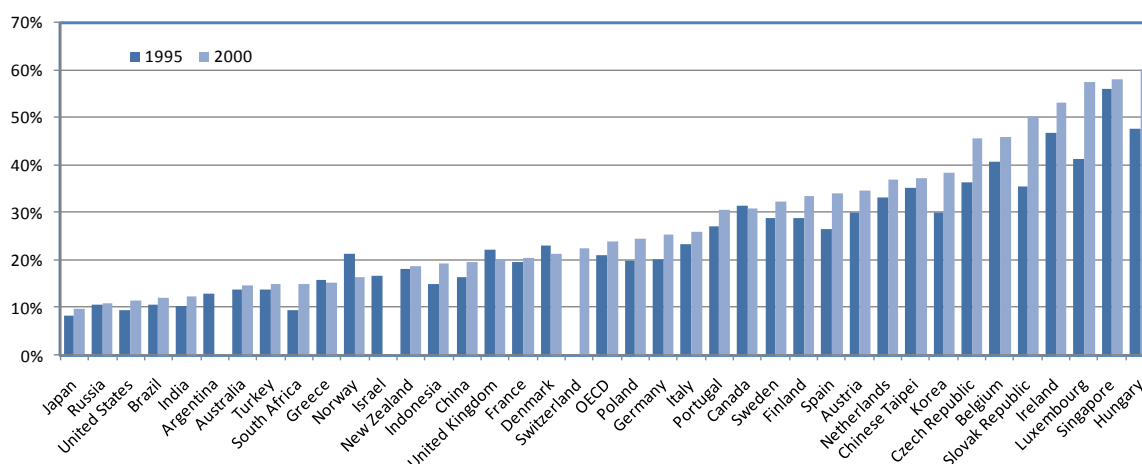
- (1) 1995 data is 1994/95 for Australia, 1995/96 for New Zealand, 1996 for Turkey, 1997 for Argentina, 1996 for Chinese Taipei, and 1993/94 for India; no data for Iceland, Mexico and Switzerland.
- (2) 2000 data is 1998/99 for Australia, 1999 for Greece, 2002/03 for New Zealand, 1998 for Turkey, 2001 for Chinese Taipei, and 1998/99 for India; no data for Iceland, Mexico, Argentina and Israel.

Source: De Backer and Yamano (2008) from OECD Input-Output Database.

Figure 13. Import content of exports, individual industries, OECD¹, 1995² and 2000³

- (1) OECD excludes Iceland, Mexico and Switzerland for 1995 and Iceland and Mexico for 2000.
- (2) 1995 data is 1994/95 for Australia, 1995/96 for New Zealand, 1996 for Turkey, 1997 for Argentina, 1996 for Chinese Taipei, and 1993/94 for India; no data for Iceland, Mexico and Switzerland.
- (3) 2000 data is 1998/99 for Australia, 1999 for Greece, 2002/03 for New Zealand, 1998 for Turkey, 2001 for Chinese Taipei, and 1998/99 for India; no data for Iceland, Mexico, Argentina and Israel.

Source: De Backer and Yamano (2008) from OECD Input-Output Database.

Figure 14. Import content of exports, individual countries, 1995¹ and 2000²

(1) 1995 data is 1994/95 for Australia, 1995/96 for New Zealand, 1996 for Turkey, 1997 for Argentina, 1996 for Chinese Taipei, and 1993/94 for India; no data for Iceland, Mexico and Switzerland.

(2) 2000 data is 1998/99 for Australia, 1999 for Greece, 2002/03 for New Zealand, 1998 for Turkey, 2001 for Chinese Taipei, and 1998/99 for India; no data for Iceland, Mexico, Argentina and Israel.

Source: De Backer and Yamano (2008) from OECD Input-Output Database.

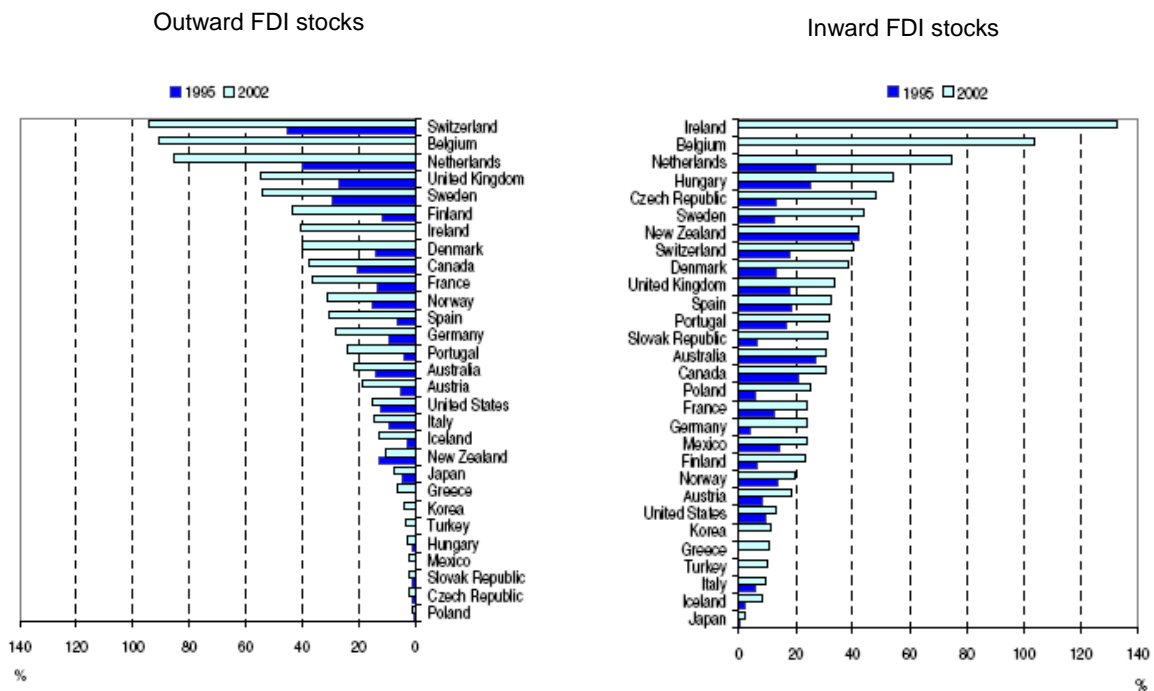
Both outward and inward FDI stocks have increased

70. The globalisation of value chains can also be evidenced in the considerable increase in both outward and inward FDI stocks over GDP in most OECD countries (Figure 15).⁷³ Intra-firm trade is becoming increasingly important and available data shows that the share of intra-firm exports in total exports of affiliates under control varies from 20% in Japan to 60% in the US and 70% in Sweden (OECD, 2007a). This means that in general manufacturing affiliates under foreign control trade more than their domestic counterparts, suggesting that foreign direct investment has been a key driver of the globalisation of the value chain.

71. This increasing prevalence of **global value chains enhances competition and the pursuit of efficiency on a global basis**, as value chains compete with each other. Companies who control global value chains increasingly compete with each other through how effectively they can efficiently manage the production and the innovation process in the global value chain (Box 12). While participants in value chains have an incentive to cooperate with each other in order to compete with other value chains, there is also competition within the value chain in order to gain a larger share of the final value added.

73. Figure 2.4 and 2.5 in OECD(2007a).

Figure 15. Outward and Inward FDI stocks of OECD countries as a percentage of GDP (1995-2002)



Source: OECD(2007a)

(Source: ibid)

Box 12. Globalisation and Innovation – Case of Nokia

The Nokia corporation is today Finland's largest enterprise and is the world's largest manufacturer of mobile devices with a global market share of nearly 40% in 2007. A combination of early deregulation of the Finnish telecommunication market, a favourable trade and investment environment such as integration of Finland into the EU Single market, successful implementation of a global corporate technological and marketing strategy, and some supportive government policies have allowed Nokia to evolve from a national/regional company in 1990 (30% of sales were domestic and 60% in Europe) to a truly global company (1% of sales were domestic and 30% Europe) at present.

Nokia now produces mobile phones in 10 manufacturing facilities in a total of 9 countries (Brazil, China, Germany, Finland, Hungary, India, Mexico, Korea, and UK), sources components from over 30 economies around the world and sells mobile devices in 150 countries.

As the average mobile phone is made up of 400 electronic components (e.g. microprocessors, chipsets, cameras, batteries and charges), mechanical components (e.g. covers, connectors, switches and antennas) and software, Nokia procures an average 275 million components to produce 900,000 finished mobile phones daily at the above 10 manufacturing locations. Supply chain management and logistics has become one of Nokia's core competencies and Nokia is increasingly attentive to regulatory changes that affect the trading of components, including tariffs, import/export procedures as well as various regulations.

While collaborating with partner companies was important in the past, it is even more so at present. Sources of innovation can emerge in different companies in different parts of the world, and Nokia increasingly considers itself as an extended enterprise with an orchestration capability.

Source : TAD/TC/WP(2008)6/PART2A and presentation by Nokia at the Global Forum on Trade, Innovation and Growth

(3) *Opening up of new opportunities for SMEs and developing countries*

72. Large MNEs have been the main drivers of innovation as evidenced in the higher rates of innovative companies in surveys, their higher share in total R&D, larger number of patents etc. SMEs however are by no means less important as they constitute a large part of the economy in many countries. The fragmentation of the production process and changes in the structure of global production networks has meant that **companies no longer need to excel in a wide range of areas in order to add value.**⁷⁴ Global value chains present an opportunity for small companies to add large value by excelling in one part of the value chain.⁷⁵ New niches for the supply of novel products and services continuously emerge and allow SMEs to exploit their flexibility and their ability to move quickly (OECD, 2007a).

73. A recent OECD study based on 20 case studies in five representative industrial sectors find that (1) participation in global value chains enhances SME internationalisation and growth, and assists in gaining stability, (2) small firms that focus on multipurpose technologies have secured their position in the market by becoming specialised suppliers serving different global value chains, (3) SMEs themselves increasingly choose to outsource, even offshore, non-core activities when this allows them to gain competitiveness, (4) cooperation with partners upstream and downstream improves the small firms' efficiency, and (5) innovating and keeping up with new technologies are seen by SMEs as a requirement for their successful participation in global value chains (OECD, 2007d).⁷⁶ A recent OECD policy survey⁷⁷ on programmes to foster enterprise growth shows that internationalisation of SMEs is a core policy area for the promotion of innovation,⁷⁸ and emphasises that for smaller countries, to realise growth inevitably means success in the international market.

74. Once a company has successfully entered a global value chain, there are **opportunities to enhance its position in the global value chain**, and some developing countries have taken advantage of such opportunities, especially in Asia.⁷⁹ Participation in a global value chain may induce the firm to improve its efficiency in individual activities; to change the mix of activities; or to try to innovate by

74. A US study states that the development of foundries, particularly in Chinese Taipei, likely allowed a wider range of fab-less companies to develop in the United States than may have been possible without the existence of foundries. These new developments allow smaller companies to overcome the high entry barriers posed by the costs of fabrication plants (US GAO, 2006).

75. One example is Qualcomm in wireless communications. Starting out as a small venture in 1985, it has fast grown into a global provider for Code Division Multiple Access (CDMA) technology. Another is Samsung which was the first to incorporate Qualcomm's technology in mobile telephones and used this to become a global leader within a span of a couple of decades. One may even say that neither Qualcomm nor Samsung would have been so successful were it not for each other (and trade which has facilitated this).

76. OECD (2007d) also refers to the challenges global value chains pose to SMEs such as (1) awareness and understanding of the structure and dynamics of global value chains by SMEs, (2) lack of SMEs' understanding of their competitive strengths, (3) inadequate availability of managerial and financial resources and poor ability to upgrade technology and innovate, (4) difficulty in fulfilling product standards and quality required for participation in global value chains, and (5) shortcomings in ability to manage their intellectual assets including through protection of intellectual property rights when appropriate.

77. CFE/SME(2008)3

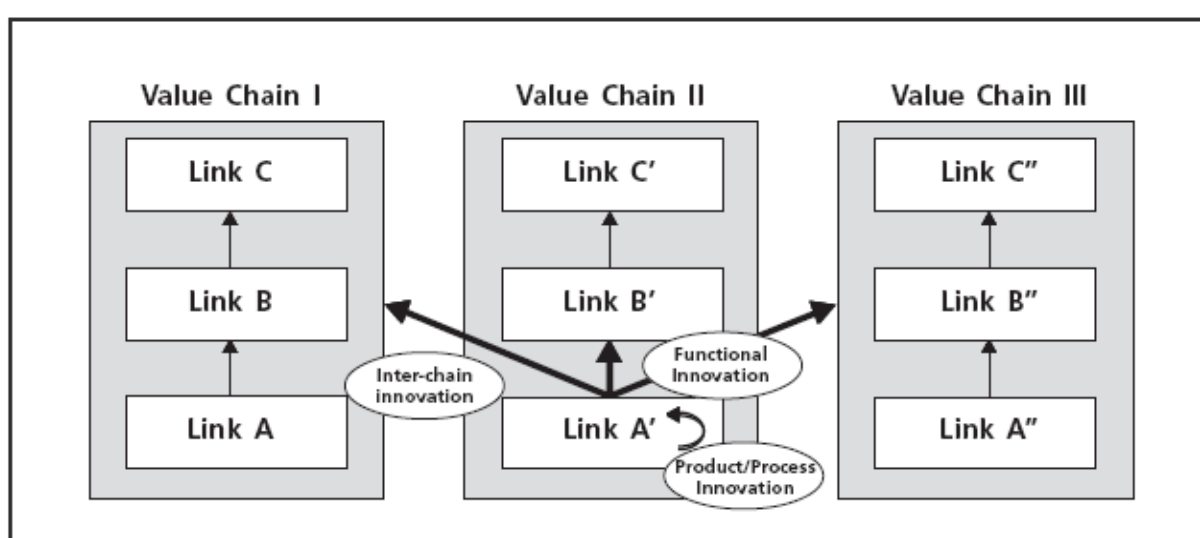
78. Policies to improve the business environment and cut red tape, R&D support, promotion of innovation including non-technological innovation, ICT use, entrepreneurship education, and financing were the other policies considered important.

79. Figure 2.18 and Figure 2.20 in OECD(2007).

moving into another value chain (UNIDO, 2004). A recent study has found that firms involved in Global Value Chains by buying from or selling to multinationals innovate more than firms that have weaker relationships.⁸⁰

75. Figure 16 illustrates four ways through which a company can enhance its position in the global value chain. The most basic ways are through product and/or process innovation.⁸¹ Another way a company can enhance its position is through functional innovation where companies change the mix of activities. A typical example is where a company who only does contract manufacturing of clothing starts to design its own clothing (See Box 13). Yet another way a company can enhance its position is through inter-chain innovation where a company enters another value chain. Knowledge that had been accumulated in one global chain (e.g. circuit boards) may be applicable to another (e.g. mobile telephones) as could be seen in the contract manufacturing industry in electronics.

Figure 16. Innovation Trajectories



Source: UNIDO, 2004

76. The global value chain thus may allow successful innovators having good and new products/processes to access global markets, upgrade their technological capabilities and move up the value chain. The flipside of this is that established companies, and in the same vein industries in countries, can be more easily driven from established market positions in the global market. From this point of view, while the emergence of **global value chains increases the potential returns** for a successful innovator selling to the global market, it also **increases the risks associated with not innovating** and/or leaving some parts of the global markets untapped. The difference between winners and losers may be becoming more pronounced. From a national point of view, there is an even greater need than before to have in place a policy environment conducive to the use of global value chains.

80. Gorodnichenko et al (2008) analyses a data set of over 11,000 firms from 27 emerging economies and find that firms that have stronger vertical relationships with multinationals, either domestically (by supplying them) or out of the country (by exporting or importing), innovate (by introducing new products, new technology or gaining new accreditation) more than firms that have weaker relationships.

81. A production process may often be modified to adapt to a new environment. For example, processes may be changed in response to higher abundance of labour.

77. The emergence of global value chains may imply that the **costs of tariffs and other barriers to trade** are becoming **more costly for governments than in the traditional trade environment**. This may in part be due to the possibility for tariffs to be compounded as inputs are moved inside the global value chain to form the finished product. More important however may be the fact that as competition between global value chains become intense, processes may be moved to another country if the cost of conducting a certain process (importing the input, processing it and exporting the output) becomes too expensive. While in the traditional trade world, tariffs on inputs may have just led to a decrease in export competitiveness of the final good and decrease in sales, now tariffs on inputs may lead a process to be moved to an entirely new country.

Box 13. Moving up the global value chain – Case of Sri Lanka

The garment industry in Sri Lanka has emerged from modest beginnings to become an important driver of the economy. The industry currently contributes about 40 percent of the industrial production of the country, accounts for 8 percent of the GDP, and earns about 45 percent of the country's export revenues. The garment industry which was initially born as a result of quota-hopping East Asian FDI in the 1970s, has rapidly grown with the entry of local entrepreneurs. The Sri Lankan garment industry started off in 'contract manufacturing', the business of assembling garments (cutting and sewing) based on designs provided by foreign buyers, producing garments according to customer requirements. Manufacturers such as MAS Holdings and Brandix Lanka have built a reputation for quality and reliability catering to a wide range of brand names such as GAP, Marks & Spencer, Nike, Ralph Lauren and Victoria's Secrets. Over the years, the industry has shifted to value added garments such as lingerie and specialty wear.

However, with the impending phase-out of the quotas, it became clearer that Sri Lankan manufacturers cannot compete with low cost producers such as China and India based on cost. Larger manufacturers such as Brandix and MAS are thus striving to become a total service provider, which would not only cut and sew garments but would also undertake several additional activities to cover the entire supply chain, including design and product development, and offer value added services to its customers. They have actively introduced new technologies such as computer aided design and manufacturing (CAD/CAM) and enterprise resource planning (ERP) systems to facilitate collaboration with foreign partners, and are adapting to customer concerns for example by introducing organic and fair-trade garments, and green manufacturing often with partnership cooperation. For example, MAS has partnered with Nike to introduce the world's first ultra-lightweight sport bra. MAS has collaborated with its Lace manufacturing partner, Noyon Dentelle of France to develop a new line of support panties with minimal seams.

An additional significant development is the use of own-brands. MAS, a leading manufacturer of intimates, recently launched a range of intimate wear under its own brand label of *Amante* in South India in 2007. The product builds on the technological capabilities that the company has accumulated through its experience as a contract manufacturer and uses the company's knowledge of the South Asian market. While moving up the global value chain poses a significant challenge, some of the larger garment manufacturers in Sri Lanka have made significant investments in technology, which is beginning to pay off by allowing them to move up the global value chain.

Source : Based on TAD/TC/WP(2008)6/PART2/C

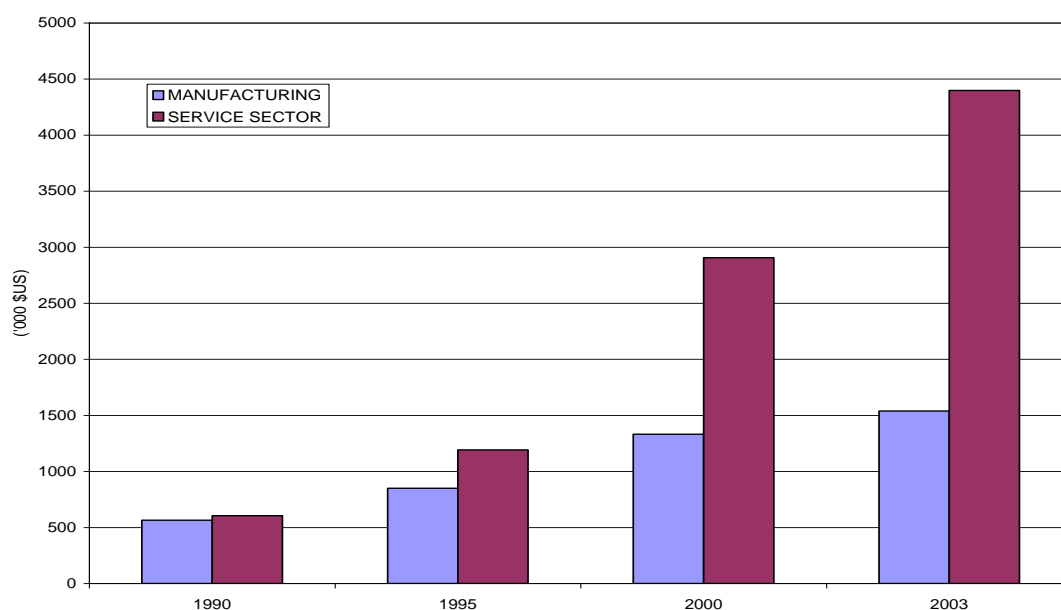
(4) *Expansion of global value chains to services*

78. While offshoring was initially limited to goods, technological progress especially in ICT has led the way for the **globalisation of production in software and services**.⁸² This is partly reflected in the rapid shift of OECD FDI into services. The OECD outward FDI position in services has grown at an annual average rate of 16.6 per cent, more than double the annual rate of growth in the FDI outward position in the manufacturing sector, with services now accounting for 2/3 of the OECD outward FDI position (OECD 2006d, Figure 17). The growth in services partly reflects the blurring boundary between manufacturing and services, as businesses specialise and shed various activities which can include anything from research and development, procurement, logistics, manufacturing, information technology, legal departments to specialised service producers.

82. See Engman (2007) for case studies on the outsourcing of business process services and information technology services to China, the Czech Republic, India and the Philippines.

79. While offshoring in goods remains the predominant form of offshoring (OECD, 2007b), the increasing possibility of services offshoring has fuelled concerns related to offshoring (See Box 14) as numerous papers indicate that millions of jobs previously thought to be “safe” from the effects of trade may be affected.⁸³ OECD (2007b) finds that the data available shows that **new job creation in the service sector offsets job destruction from all causes combined, including offshoring.**

Figure 17. The composition of OECD FDI has shifted massively towards services



Source: OECD International Investment Statistics database.

80. The services industry has traditionally been low in R&D intensity itself although this does not signify the lack of innovation. For example, services now comprise one-quarter of total business R&D in the OECD, and more than one third in Australia, Denmark, the United States, Canada, the Czech Republic and Norway (OECD, 2006c), which is considerably lower than services’ share in GDP and employment. Nevertheless, services is becoming much more important in R&D, and between 1990 and 2003, service sector R&D has grown at an annual rate of 12%, compared to 3% for manufacturing.

81. The business services sector is of particular importance of the economy as it has significant forward linkages – i.e. business services provide inputs to other industries. Analysis of forward linkages using input/output tables show that the business services sector shows significantly stronger forward linkages than the average for the manufacturing sector, and these linkages are dispersed among a broad range of downstream industries (OECD, 2007e). This implies that increased innovation in these sectors have greater effects on the productivity and competitiveness of user industries.

82. Looking back at the effects of ICT on innovation and growth, lower prices led to wider diffusion and increased productivity in user industries. As noted in Mann (2007), services sectors such as wholesale trade, securities and commodities brokers, depository institutions and communications led the US economy in IT investment and productivity growth. As globalized production of IT hardware has led to lower prices and wider diffusion of IT products leading to higher levels of innovation, expansion of global value chains

83. See for example Blinder (2006) and Bivens (2005).

to services can be expected to have a similar effect. Mann (2003) predicts that "since the demand for software and IT services is more price elastic than for IT hardware, the potential increase in investment, productivity growth and job creation for the globalization of IT services and software is even greater than that experienced in the 1990s from the globalization of IT hardware".⁸⁴ However, there is one key difference between software services offshoring and goods offshoring: services offshoring does not need the same physical infrastructure (i.e. while telecommunication infrastructure is a necessity, requirements on transportation and industrial infrastructure are less stringent), and thus **can be set up more easily** and it is **more labour intensive**.

83. How can countries become a part of the global value chain in services and promote innovation in services? A recent study by an Irish Agency responsible for the promotion of industry provides some interesting looks at the drivers of and barriers to innovation in the services sector (Forfas, 2006). In terms of drivers, it finds that (1) client and consumer demand, (2) competition, (3) regulatory pressure, (4) innovative clusters and (5) effective use of technology are important. In terms of barriers, it finds that (1) a weak culture of services innovation, (2) regulation, (3) skill shortages and (4) industry and organizational structures can be detrimental to services innovation. The regulatory aspect is particularly important for services: telecommunications deregulations has provided the basis for new service providers and products, and clear and transparent regulatory regimes provide a fertile ground for innovation in financing sector activities while too rigid regulations and regulatory barriers to new types of services will present significant barriers to services innovation.

84. This would suggest that in order to become a part of the global value chain in services and to promote innovation in services, it would be important to have a freer trade and investment environment, in particular with regard to the GATS and in ICT goods. Freer trade and investment will facilitate networking with clients and consumers and will promote competition. Movement of skilled labour will ameliorate skill shortages while freer trade in ICT products through expansion and deepening of ITA will lead to better access to technology.

Box 14. Concerns related to offshoring

The increase in offshoring has led to a considerable debate on whether this has adverse effects on the offshoring economy, even to consider whether it is desirable and/or possible to prevent offshoring. While there is no doubt that offshoring affects specific workers and adjustment costs can be considerable, a recent OECD study finds that trade has had no significant effect on the overall unemployment rate of OECD countries (TAD/TC/WP(2007)7). New job creation in the services sector seems to offset job destruction from all causes combined, including offshoring. However, the manufacturing sector in the vast majority of OECD countries is losing workers primarily because of technological change rather than trade. While many studies look at the jobs lost through offshoring, relatively few studies look at the job embodiment of exports. A recent OECD study analysed the job embodiment of exports and imports using input output data and finds that although there are considerable differences between countries, the jobs embodied in exports and imports tended to even out (Table 6).

To the contrary, some studies point to the **considerable benefits of offshoring** such as higher consumer incomes because of the low prices of imported offshore goods, the improved productivity of firms that engage in offshoring, better control over inflation and enhanced export capacity (OECD, 2007b). The same study points out that improved competitiveness of companies due to offshoring may allow them to expand their market shares, profits and capital spending, which can feed through to new job creation in their home countries. Amiti and Wei (2007) look at the sourcing of services inputs from abroad by US firms and find that (1) although the level of service offshoring is still low compared to material offshoring, it is growing rapidly and (2) offshoring has a positive effect on productivity: service offshoring accounts for around 10 percent of labour productivity growth over the period 1992-2000 compared to material offshoring for 5 percent despite lower levels of services offshoring. According to a survey, Japanese companies see considerable merit in business activities in the East Asian region through enhanced markets, increases in the export of intermediate products and specialisation in high value added products leading to improved productivity

84. One important characteristic of services in this respect is that like IT goods, it is both income and price elastic (Mann, 2007).

(METI, 2007). Wakasugi et al. (2008) find through analysis of a survey of Japanese manufacturing firms that firms conducting offshoring recorded a 2.5% higher growth rate in sales, a 1% higher growth rate in labour productivity, and a 0.5% higher annual growth rate of wages than the firms that did not engage in offshoring. Ando and Kimura (2007) analyse firm level data and find that manufacturing firms expanding operations in East Asia are more likely to increase domestic employment than other manufacturing firms and that the growth of domestic employment of globalizing manufacturing firms is higher by as much as three to eight percent, which provides support to the notion that offshoring companies become more competitive than purely domestic companies.

Table 6. Job embodiment of international trade

	Jobs embodied in imports (thousands)	% of total employment	Jobs embodied in exports (thousands)	% of total employment	Net (thousands)	% of total employment
Australia (1998)	1 382	15.5	1 236	13.9	-145	-1.6
Austria	1 142	27.7	1 057	25.6	-85	-2.1
Canada	3 040	19.9	4 007	26.3	967	6.3
Finland	515	22.4	597	25.9	81	3.5
France	3 519	14.5	3 754	15.4	235	1.0
Germany	7 703	19.9	8 245	21.3	542	1.4
Hungary	1 390	36.3	1 136	29.7	-254	-6.7
Ireland	837	49.3	619	36.5	-218	-12.9
Italy	4 359	18.8	4 624	20.0	265	1.1
Japan	10 319	15.5	6 359	9.5	-3 961	-5.9
Korea	4 909	23.2	4 994	23.6	85	0.4
Netherlands	1 941	23.9	2 368	29.1	427	5.3
New Zealand	240	18.6	296	23.0	56	4.3
Norway	605	26.3	555	24.1	-50	-2.2
Poland	372	24.7	320	21.3	-52	-3.5
Portugal	1 341	27.7	919	19.0	-421	-8.7
Spain	3 484	22.1	2 873	18.3	-611	-3.9
Sweden	1 016	23.8	1 219	28.6	203	4.8
Switzerland (2001)	723	22.0	753	23.0	30	0.9
United Kingdom	5 967	20.3	5 793	19.7	-174	-0.6
United States	13 731	9.2	11 463	7.7	-2 268	-1.5

(Source: Edited from De Backer and Yamano (2008))

5. Conclusions

85. To ensure sustained economic growth globally, it is important to maintain and/or increase innovation on a global basis by promoting (1) creation of new technology and knowledge, (2) commercialisation of such technology/knowledge (implementation of innovation) in the source country, (3) diffusion of innovation, and (4) further commercialisation in recipient countries. Stronger innovation and diffusion of innovation is especially important for addressing global challenges such as meeting increased demands for energy and food, and in particular for meeting the challenges presented by climate change.

86. Business is the main driver of innovation. Multinational enterprises are an especially important segment as drivers of innovation and the diffusion of innovation. Improvement of the global trade and investment environment has facilitated innovation and its diffusion in the past, and has provided an enabling global framework for multinational enterprises to prosper. Relatively free trade and investment has allowed the cross-border integration and reorganisation of businesses on a global basis and has led to the emergence of global value chains – an innovation in its own right which reorganises various activities across borders. Multinationals are increasingly conducting all activities, be it R&D, production or other ancillary services where they can be done best making full use of the relatively free trade and investment environment.

87. This paper finds that trade and investment can affect innovation in various ways.

- **Imported capital and intermediate goods** are important for **technology transfer**, which can be realised both through a “technology effect” (the embedded technology in goods and services) and a “price effect” (through rapid diffusion of new technologies enabled by lower prices of imports). The price effect is especially important for products with network effects such as ICT goods. **Licensing** or trade in technology can also be an important conduit for technology transfer, which has allowed some middle income countries to catch up rapidly as intellectual property rights systems have been improved.
- **FDI also can lead to technology transfer** as well as having **spill-overs to other domestic companies** through enhanced competition, imitation and demonstration, worker mobility and spin-offs, backward and forward linkages. Spill-overs however are by no means automatic, and depends on host country policies and absorption capacity. As **innovation involves risk, the general business environment** such as macroeconomic stability, political stability, respect for property rights, basic infrastructure such as telecommunication, electricity, transportation, supply of human resources and capital are **also important factors which affect absorption capacity**.
- Trade and investment can affect innovation through **competition**. An increase in competition can have both positive or negative effects on innovation depending on levels of existing competition, nature of the industry, and existing levels of technology in incumbent companies. **Standards** can constitute technical barriers to trade and can affect the innovation process. **Size of the domestic market can be a mixed blessing when standards differ from international standards** as the size of the domestic market may permit a domestic focus precluding companies from seeking export markets while competitors achieve economies of scale in the larger global market.
- Exports can affect innovation through **learning by exporting** and **scale economies**. Foreign customers often provide information about product designs, materials, labelling, packaging and shipping, assistance to reduce costs and control quality, help in the factory layout etc., and lead to the introduction of new technologies. **Exports also extend the size of the market over which margins can be earned**, and allows for the exploitation of economies of scale, providing greater

incentives to increase investment in innovation. MNEs from smaller countries cannot succeed without the benefit of exports.

- The gradual change from a closed- innovation system to an “open” innovation system whereby innovations are made through the interaction between firms, suppliers and customers as well as with other firms and universities is making it more costly to have restrictive trade and innovation policies. restrictive trade and innovation policies may make it more costly to communicate with suppliers and customers.
- Advances in technologies in communications and logistics and the decline of trade and investment barriers around the world have given rise the **emergence of global value chains** which is an **innovation in its own right**. MNEs have been the driver and trade and investment have been enablers. **Global value chains present new opportunities for new entrants** (i.e. developing countries and small and medium enterprises). Companies no longer need to excel in a wide range of areas in order to add value, decreasing entry barriers. Global value chains enhance competition and the pursuit of efficiency on a global basis as value chains compete with each other. While global value chains present opportunities to enhance position in the global value chains, there is always a possibility of exclusion. In the age of global value chains, functions are conducted where it can be conducted most efficiently. Nations, companies and people constantly need to adapt and innovate as they can quickly lose their differentiation and competitive advantage. **Services offshoring** may present especially important opportunities for developing countries.
- The emergence of global value chains may imply that the **costs of tariffs and other barriers** to trade are becoming **more costly for both companies and governments than in the traditional trade environment**. This may in part due to the possibility for tariffs to be compounded as inputs are moved inside the global value chain to form the finished product. More important however may be the fact that **high tariffs can possibly lead to exclusion from global value chains**.

88. From a trade and investment policy perspective, this paper concludes as follows:

- Trade and investment can affect innovation in various ways; as sources of technology, through competition effects, and through scale economies. While trade and investment in many cases promote innovation (i.e. technology transfer through imports, increased incentives through competition, positive effects of exports on scale economies) , in some respects, trade and investment can have negative effects on innovation (i.e. negative effect of imports on scale economies, decreased rent available for innovation).
- While restrictive trade and investment policies are sometimes employed on the basis of “developing” domestic industries, the increasing use of global value chains based on the increasingly liberal global trade and investment environment suggests that potential negative effects of such restrictive trade and investment policies may have through the possible exclusion from global value chains may be greater than the benefits.
- As MNEs are a key conduit for technology transfer and can provide an opportunity for inclusion into global value chains, it is becoming important to provide a stable trade and investment environment conducive to MNEs.
- From this point of view, the successful conclusion of the Doha Development Agenda would contribute by lowering trade barriers for both goods and services, thereby providing access to more technology and promoting competition in the domestic market through imports on the one

hand, and providing access to export markets which may be important to promote innovation in countries with smaller domestic markets on the other. Regional and bilateral trade agreements could serve as a second best solution to the extent they support the multilateral trading system.

- Increased predictability through tariff and services commitments can also contribute to a more stable trade and investment environment and contribute to inclusion into global value chains
- In particular, expanding the scope and participation in the Information Technology Agreement could (1) improve access to cheaper ICT goods, which could lay the basis for the diffusion of marketing and organisational innovations and (2) open the door to participation in related global value chains in this growing area. This would also contribute to better participation in global value chains related to services and an increase in innovation in services.
- Eliminating non-tariff barriers (e.g. differing standards) that impede effective competition between markets, could also contribute to greater innovation.
- In addition to trade and investment liberalisation, governments should strive to improve the business environment through further regulatory reform and by improving access to financing, and encouraging human resources development.
- Ensuring that protection of intellectual property rights on a global basis will work so as to improve technology transfer while providing sufficient benefits to the innovator to maintain robust incentives for new cutting edge innovations will be increasingly important. The TRIPs agreement contributes to this end.

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