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Trade and Innovation

SYNTHESIS REPORT

Nobuo Kiriyama

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Abstract

TRADE AND INNOVATION – SYNTHESIS REPORT

by

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Innovation is critical to creating new sources of growth. Trade is one of the framework conditions that can strengthen innovation in the business sector, as set out in the OECD Innovation Strategy in 2010.

This paper broadly sets out three channels through which trade affects innovation. First, imports and foreign direct investment (FDI) as well as trade in technology serve as channels of technology diffusion. Second, imports, FDI and technology licensing contribute to intensifying competition, which can affect incentives for innovation. Third, exports can affect innovation as it serves as a learning opportunity and gives incentives for innovative activities.

The benefits of technology diffusion depend not only on the channels of diffusion but also on the absorptive capacity (that is, the capacity to assimilate and apply new information), which covers a number of policy agendas that go beyond typical trade policy issues. Multilateral trade liberalisation, including both tariff and non-tariff liberalisation as well as protection of intellectual property, contributes to ensuring the link between trade and innovation that are discussed in this paper.

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Keywords: trade and innovation, international technology diffusion, competition and innovation, exports and innovation, World Trade Organization (WTO), multilateral trade negotiations, non-agricultural market access (NAMA).

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Executive Summary[1]

Innovation is critical to creating new sources of growth. In 2010 the OECD developed an Innovation Strategy which provides analysis and policy guidance on a broad range of on issues ranging from education to green growth, and advocates an approach which takes into account the interplay of different policy domains.

Trade is one of the framework conditions that can strengthen innovation in the business sector. This paper explores the channels through which trade contributes to innovation and sets out policy implications, drawing on the key findings from the two groups of studies on trade and innovation in the Trade Committee in 2007-08 and 2009-11. In doing so, results of the previous studies have been supplemented by empirical (econometric) findings in the existing economic literature, in order to place the findings from previous works in a broader context.

This paper sets out broadly three channels through which trade affects innovation, i.e. technology diffusion (through imports, foreign direct investment [FDI] and trade in technology), competition and exports.

Imports and FDI are the two prominent channels of technology diffusion which have been extensively tested. Imports allow domestic firms access to foreign technology which may work as a basis for product innovation, process innovation with superior capital goods and marketing and organisational innovation through effective deployment of information and communications technology (ICT). FDI can also serve as a channel for domestic firms to access superior inputs from upstream foreign affiliates (vertical spillovers – forward linkage), or to superior technologies from their downstream foreign affiliates (vertical spillovers – backward linkage). Imports and FDI can both affect domestic firms operating in the same industry by providing new insights from new foreign products and from business operations (horizontal spillovers). Moreover, trade and FDI both tend to accompany intangible knowledge flows.

Trade in technology, in particular through licensing, is another important channel of diffusion, although with significant variations in different sectors. Licensing is at the centre of the innovation process in bio-pharmaceutical products, and has been an essential instrument in the development of the chemicals industry in recent decades. Yet this channel appears to be less systematically explored compared to the other two.

Imports and FDI as well as technology licensing contribute to intensifying competition. How competition impacts innovation has been analysed according to two sharply contrasting predictions: on the one hand, competitive pressure can work as an incentive for a firm to become more efficient, and on the other hand competition reduces

1. This document and any map included herein are without prejudice to the status of or sovereignty over any territory, to the delimitation of international frontiers and boundaries and to the name of any territory, city or area.

the monopoly rents that induce a firm to invest in innovation. Yet today it is generally recognised that they are not necessarily contradictory, and one hypothesis posits that it may depend on the technological capabilities. Econometric evidence points to a positive effect of competition on productivity of the firms, although evidence is mixed about whether the impact depends on the technological capability of the firms. Studies generally agree that trade-induced competition contributes to productivity improvement for the economy, including through the shift of output towards more efficient firms as well as through improvement in individual firms.

The role of exports has seen a major shift in the economic literature. Even though it has been established that exporting firms are more productive than non-exporting firms, the direction of causation has been debated. Despite an abundance of anecdotal evidence in favour of the "learning-by-exporting" view, econometric studies have found it difficult to find clear evidence to support it, and the "self-selection" view has generally been more widely accepted in the economic literature. Recent empirical studies are shifting the centre of gravity towards a positive role of exporting on innovation and productivity, either by emphasising the interaction between exporting and innovative investment, which together upgrade the productivity of exporting firms, or by further exploring the "learning" channel from exporting.

Turning to policy issues, three sets of issues are discussed: absorptive capacity, trade liberalisation and the protection of intellectual property rights.

Benefits of technology diffusion depend not only on the channels of diffusion but also on the absorptive capacity, both at firm level and at country level. Absorptive capacity is not limited to skill levels of the workforce or R&D capacities, but is broadly understood, especially at the country level, to cover a broad ranging policy agenda including political and macroeconomic stability, quality of regulation and the development of infrastructure.

Many studies reviewed in this paper show sizable productivity resulting from unilateral or bilateral trade liberalisation. Many studies further suggest that multilateral trade liberalisation is preferable; multilateral liberalisation magnifies the impact of lowering import prices, gives better export opportunities to exporters, and ensures long-term pro-competition effects. And even though tariffs have been significantly reduced in recent years, substantial tariffs remain in some sectors. Technical regulations are also important for pharmaceuticals, chemicals and ICT, and major trading countries have addressed this issue in many forums, including the World Trade Organization (WTO), but also through bilateral or plurilateral co-operation among regulatory authorities, for example in pharmaceuticals. These issues of liberalisation in tariff and non-tariff barriers are being negotiated in the Doha negotiations.

Finally, the state of domestic intellectual property legislation and enforcement has improved in recent years, and evidence suggests that this has facilitated technology diffusion through various channels, including FDI and trade. Nonetheless it has been pointed out that some problems remain in some countries, and ensuring protection of intellectual property remains an important policy issue.

I. Introduction

Innovation, which involves both the creation and diffusion of products, processes and methods, is a critical part of creating new sources of growth, as it provides the foundation for new industries, businesses and jobs (OECD, 2010a). In 2007, the OECD Ministerial Council asked the OECD to develop a broad-ranging Innovation Strategy. The report to the Ministerial Council in 2010 (OECD, 2010a, 2010b), provides analysis and policy guidance on a broad range of issues, and advocates an approach which takes into account the interplay of different policy domains (OECD, 2010b).

Against this background, the Trade Committee initiated work on "trade and innovation". The first group of studies was carried out in 2007-08, and highlighted various linkages between trade and innovation, drawing on case studies of various sectors in countries at different levels of development. Building on those studies, the Trade Committee conducted a second group of studies in 2009-11, focusing on specific sectors (Tables 1 and 2). This report is based on the results of these studies, and synthesises the linkages between trade and innovation with a focus on trade policy issues.[2]

Table 1. Trade and innovation studies in 2007-08

Year	Country	Sector
2008		Synthesis report
2008	Finland	Telecom Equipment
2008	Korea	ICT
2008	Sri Lanka	Textile and Clothing
2008	New Zealand	Agriculture
2008	South Africa	Agriculture

Table 2. Trade and innovation studies in 2009-11

Year	Sector
2011	Synthesis report
2011	ICT, Part 1 ("ICT report, Part 1")
2011	ICT, Part 2 ("ICT report, Part 2")
2011	Pharmaceuticals ("pharmaceuticals report")
2010	Chemicals ("chemicals report")

Four types of innovation can be distinguished: product innovations, process innovations, marketing innovations and organisational innovations. Product innovation is the introduction of a good or service that is new or significantly improved with respect to its characteristics or intended uses. Process innovation is the implementation of a new or significantly improved production or delivery method. A marketing innovation is the implementation of a new marketing method involving significant changes in product design or packaging, product placement, product promotion or pricing. An organisational

2. The studies in Table 1 have been compiled in OECD (2008a).

innovation is the implementation of a new organisational method in a firm's business practices, workplace organisation or external relations (OECD, 2005 ["Oslo Manual"]). All innovations must contain a degree of novelty, which can be new to the firm, new to the market or new to the world (*ibid*.).

Trade is one of the framework conditions that can strengthen innovation in the business sector. As OECD (2010b) emphasises, given the increasingly central role of innovation in delivering a wide range of economic and social objectives, a "whole-of-government" approach to policies for innovation is needed. The goal of this paper is limited to a focus on the linkages between trade and innovation, drawing heavily on the previous studies of the Trade Committee, and supplemented by recent economic literature.[3]

The report is organised as follows. Section II sets out an overview of trade and innovation linkages, which run in both directions: while innovation affects trade flows, at the same time trade flows affect innovation. Section III discusses the contribution of trade to innovation through three channels: technology diffusion (through imports, FDI and technology licensing), competition and the role of exports. Section IV shifts to policy issues, and covers absorptive capacity, trade liberalisation and protection of intellectual property. Section V concludes.

II. Trade and innovation: an overview

The idea that cross-country differences in technology and patterns of trade are tightly linked has been recognised since Ricardo (1817). Ricardo's insights highlighted labour productivity as the determinant of the pattern of specialisation and trade between countries. It is well-known today that differences in technological capabilities,[4] alongside factor endowments, are the sources of comparative advantage.[5]

Furthermore, "New trade theory" developed in the 1980s gives other aspects of technology, i.e. increasing returns to scale and product differentiation, the central role in explaining trade in similar products between similar countries, such as trade in manufactured goods between developed countries (Helpman and Krugman, 1985; Krugman, 1995; Krugman, 2009).

3. See Syverson (2010) for a more comprehensive survey of empirical studies on the determinants of productivity, both within the firm (managerial skills, quality of labour and capital inputs, research and development (R&D) and information technology (IT) investment, firm structure) and external to the firm (spillovers, competition, regulation, input markets flexibility).

4. The source of Ricardian comparative advantage is referred to as technology, even though it actually means labour productivity (e.g. Ricardo, 1817; Dornbusch *et al.*, 1977), which reflect non-technological factors (marketing and organisational methods) and the amount of production capital per worker. Ricardian comparative advantage can also be shaped by factors external to the firms, such as national legal systems as they influence the sectoral variation in productivity levels (Helpman, 2006).

5. See Chor (2010), Costinot (2010) and Shikher (2011) for empirical studies; WTO (2008a) pp. 33-35 and Leamer and Levinsohn (1995) for surveys of earlier empirical works. Moreover, factor-endowment can also be a determinant of the pattern of technical changes. See Acemoglu (2002), Dudley and Moenius (2007).

Technology is also an indispensable infrastructure of trade. In particular, studies suggest that development of ICT has significantly reduced the cost associated with trade, offshoring and other multinational corporate activities (ICT report, Part 2; Baldwin, 2010; Ariu and Mion, 2010; Abramovsky and Griffith, 2006; Feenstra, 1998), such as search cost, transaction cost, coordination cost and monitoring cost.

On the other hand, "until quite recently, the formal trade-theory literature has focused almost exclusively on the effects of technological disparities without delving much into their causes", even though "informal commentators see the integration of the world economy as having an important influence on the pace and direction of technological change" (Grossman and Helpman, 1995).

At the most general level, empirical studies have shown the positive effect of trade (either trade volumes or liberal trade policy) on growth, based on cross-country data. However, these studies have been questioned due to the difficulties in establishing whether growth is caused by trade or through some other channels, and in constructing appropriate measures of trade openness.[6]

Instead, two other approaches have been taken and are considered to provide more clear-cut answers (WTO, 2008a). One strand of studies has employed firm-level data to see the effect of trade on firms' productivity. The other strand has investigated the relationship between trade and international knowledge spillovers. These approaches are more concrete about the mechanism that links trade to productivity growth and technological progress, thus more pertinent to the subject of this paper.

On the other hand, this paper should be distinguished from the literature on gains from trade (e.g. Arkolakis *et al.*, 2009). The economic welfare gains from trade is not the explicit focus here; for example, even through welfare gains from importation of innovative products can indeed be substantial (Feenstra *et al.*, 2009; Añón Higón and Stoneman, 2011), the main interest of this paper is further innovation implications induced by such imports, but not the welfare gains from such imports per se.

III. Trade and innovation linkages

This section will discuss various linkages between trade and innovation. On one hand, trade can serve as an avenue of knowledge diffusion; whether or not knowledge is embodied in goods (imports) or disembodied (FDI, licensing). On the other hand, trade affects incentives of firms toward innovative activities (including R&D and other activities[7]) through competition and export opportunities. The rest of this section will examine each of these mechanisms in turn.[8]

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6. See WTO (2008a) pp. 71-72 for a survey of literature.

7. Non-R&D innovative activities include: identifying new concepts for products, processes, marketing methods or organisational changes, buying technical information, developing human skills (through training or learning-by-doing) and physical investment. See Oslo Manual, p. 36.

8. Although outside of the focus of this paper, movement of people can also be associated with innovation. Hovhannisyan and Keller (2011) shows that business travels has strong effect on innovation (patent) by facilitating face-to-face communication. Psychology

1. Diffusion of technology and innovative ideas

Access to foreign technology and knowledge can accelerate domestic innovation and growth.[9] Comin and Hobijn (2010) and Comin and Mestieri (2010) shows that the variation of technology adoption accounts for 25% of per capita income differences across countries, and another 40% is explained by the extent of technology adoption (i.e. the demand of the goods embodying the technology relative to aggregate demand). Even though the wider use of ICT may have accelerated knowledge spillovers (Wolff, 2011[10]), "the dream that when one person learns something, everyone else in the company knows it"[11] is still at a distance, and much more so with inter-firm or international spillovers; thus tracing the channel of diffusion still matters. (Keller, 2009)

International technology diffusion can take place through a number of channels, such as imports, foreign direct investment (FDI) and trade in technology. Such diffusion can take place between competitors (horizontal), within a supply chain (vertical), within an enterprise group, or from universities or government research organisation.[12]

These different channels can be complements. For example, the global emergence of chemicals industry has been a result of technology diffusion through multiple channels. Process technology licensing and supply of manufacturing equipment and catalysts by specialised engineering firms (SEFs) have been essential in reducing the entry barriers, especially for those firms without sufficient in-house technological capabilities. Established chemical companies have also been active in technology licensing and joint ventures (chemicals report). In another example, Korea's entry into semiconductor industry was achieved by foreign technology adoption through DRAM design acquisition (licensing) from US firms and manufacturing equipment purchased from Japanese firms (Kenney, 1998).

(a) Imports of intermediate and capital goods

(i) Mechanism of diffusion through imports

Trade in tangible goods can facilitate the exchange of intangible ideas.[13] Trade volume can be associated with the number of personal contacts between trading partners, which may give rise to innovative ideas; and imports may embody differentiated

literature shows that living abroad has a strong relationship with creativity (Maddux and Galinsky, 2009).

9. See Grossman and Helpman (1991) Chapter 9 for theory description.

10. Based on inter-sectoral spillovers.

11. KMPG (1999), IKON Conference Report, cited in Prichard (2000) and Currie and Kerrin (2004).

12. Based on the survey data in the United Kingdom in 1990s, Crespi *et al.* (2008a) found that information flows from other firms in the enterprise group, competitors, and suppliers have significant association with TFP growth, although they do not focus on international knowledge flows.

13. The description in this paragraph is based on Grossman and Helpman (1995) p. 166.

intermediates that are domestically unavailable, which may give new insights by using and inspecting such goods.

Imports of capital goods can involve technology diffusion. It was the case for Korean entrants to semiconductor industry, since semiconductor manufacturing equipment contains advanced knowledge and vendors are willing to teach their new users how to use it (Kenney, 1998).

The ICT report (Part 2) highlights certain positive associations between ICT imports and economic well-being across countries: (a) the increase in social savings from declining IT hardware prices is greater the larger is the net imports in IT hardware, and (b) variety in imported ICT goods is associated with higher real GDP per capita, implying that such variety may be positively associated with innovation in business process and workplace practice, although such variety does not guarantee innovation.[14] It is well-known, on the other hand, that dramatic increase of mobile phones in regions such as Africa is fundamentally changing the way the businesses there are done (Aker and Mbiti, 2010; OECD, 2010b).

(ii) Econometric work

Relationship between trade and international knowledge spillovers is examined in Coe and Helpman (1995), which shows that domestic total factor productivity (TFP) benefits not only from domestic R&D capital stock but also from foreign R&D capital stock through bilateral imports, based on a sample of 21 OECD countries in 1971-90.[15] Achrya and Keller (2009), based on 17 OECD countries in 1973-2002, further shows that the contribution to TFP by international technology transfer from the countries with the largest R&D stock (United States, Japan, Germany, France, United Kingdom and Canada) often exceeds the effect of domestic R&D, and the international R&D spillovers are markedly stronger in relatively high-technology industries, such as ICT, aircraft, chemicals and pharmaceuticals. In addition, it reveals that the majority of technology transfer from the United States and the United Kingdom occurs through imports, whereas much of it from Germany and Japan cannot be accounted for by imports (i.e. disembodied).[16]

A growing body of studies use micro data, although mostly focused on manufacturing firms and trade in goods. Many of them have examined the impact of trade liberalisation on the productivity of domestic firms in developing countries. Of particular interest to see

14. Feenstra *et al.* (2009) calculates the terms of trade gains for the IT products which experienced declines in prices due to multilateral tariff elimination under the Information Technology Agreement (ITA), but it does not consider implications of imported IT products on innovation, although a positive implication is plausible (Onodera, 2008).

15. Coe *et al.* (2009) extends the sample to 24 OECD countries in 1971-2004 and reached similar results. Schiff and Wang (2010) did a similar exercise for 24 developing countries in 1977-98 and find a significant impact of trading partners' R&D stock on the TFP of high R&D-intensity manufacturing industries. See Keller (2009) pp. 54-55 for extensions and critique.

16. Another approach to test the existence of international technology diffusion is to use patent data. See WTO (2008a) pp. 72-73.

the technology diffusion through imports[17] are those studies which distinguish trade liberalisation in inputs (interpreted as access to foreign technology) and in outputs (interpreted as heightened competition in the output market). Amiti and Konings (2007) and Topalova and Khandelwal (2011) find large positive effects of the reduction in input tariffs[18] on productivity, which are larger than the impact of output tariff reduction, based on samples of manufacturing firms in Indonesia (1991-2001) and India (1989-2001), respectively. The relative size of the diffusion effect and the competition effect on productivity may depend on other policy factors, not just on trade policy. The latter study finds that the impact of output tariffs (i.e. competition effect) is larger in industries with more likelihood of import competition (i.e. less import licensing, less exposure to exports) or more ability to adjust (i.e. less industry licensing).

Other studies find evidence that the use of foreign inputs improves productivity, such as Kasahara and Rodrigue (2008) and Halpern *et al.* (2005), based on Chilean manufacturing plants (1979-96) and Hungarian manufacturing firms (1992-2001) respectively. Stone and Shepherd (2011) also show a strong positive correlation between imports in intermediate inputs and firm-level productivity, especially for developing countries. Nishimura *et al.* (2005) finds similar results based on Japanese firms (manufacturing and non-manufacturing in 1996-2002. However, Vogel and Wagner (2009) finds that a positive link between importing and productivity is due to self-selection[19] of more productive enterprises into imports, and no clear evidence for the effect of importing on productivity emerged, for German manufacturing enterprises in 2001-05. Castellani *et al.* (2010) reaches the similar conclusion, although some post-entry effects cannot be ruled out, based on Italian firms in 1993-97.

Technologies transferred to the importers can further diffuse through supply chains. Blalock and Veloso (2007) finds that firms selling to sectors that rely more on imports have greater productivity growth than other firms, based on data on Indonesian manufactures (1988-1996), suggesting that vertical supply relationships are an important channel of technology diffusion.

Some studies look more closely into the implications on innovation, rather than productivity. Among them, Goldberg *et al.* (2010) reveals that declines in input tariffs resulted in an expansion of firms' product scope by introduction of new products, for Indian manufacturing firms (1989-1997), and suggests that imports of new input varieties fostered product innovation. In addition, lower input tariffs improved other performance indicators of firms such as output, TFP and R&D activities. Based on patent data, MacGarvie (2006) shows that inventions of French importing firms (manufacturing, trade and services, 1986-1992) are significantly more likely to be influenced by foreign technology compared to non-importers. Chemicals report also shows positive correlations between trade flows and international co-invention (based on patent data), which indicates knowledge spillovers through face-to-face contacts between inventors (cf. Montobbio and Sterzi, 2011), based on cross-country aggregate data focusing on three chemical sub-sectors, although causation appear to work differently in different sub-sectors.

17. The studies that focus on competition effect of trade liberalisation are reviewed below.

18. An input tariff refers to the tariff on the product category of a firm's input. An output tariff refers to the tariff on the product category of the firm's output.

19. See below on exports for more discussions on "self-selection" versus "learning".

(b) Foreign Direct Investment (FDI)

(i) Mechanism of diffusion by FDI

FDI can work as a conduit for technology diffusion in several ways.[20] First, inward FDI can affect domestic firms in the same industry through its business operations (horizontal spillovers), since a domestic firm may observe and copy the business practices of a foreign multinational affiliate. Second, inward FDI can affect domestic firms within the supply chain (vertical backward spillovers) if a multinational affiliate provides technology to its suppliers. Third, labour turnover (mobility) can also serve as a mechanism for spillovers associated with FDI. Fourth, acquisition by foreign multinationals may transfer technology to the newly acquired subsidiaries and upgrade their productivity. Moreover, multinationals going abroad may also acquire technological knowledge from other firms.

A number of case studies show examples of technology diffusion through FDI. The roots of the garments industry in Sri Lanka lie in investment from abroad, motivated by jumping the quota maintained under the former Multi-Fibre Agreement (MFA), and FDI has often driven product innovation (Wijayasiri and Dissanayake, 2008; Onodera, 2008). Other studies such as those on Intel’s investment in Costa Rica, and Wal-Mart’s entry into Mexico that resulted in learning externalities to domestic firms further illustrates such spillovers (Keller, 2009). In pharmaceuticals, the R&D process is expanding in geographical scope, especially involving emerging economies, with a view to reducing R&D costs (e.g. clinical trials) and tapping into their growing market opportunity,[21] and this contributes to upgrading the R&D capability in emerging economies (pharmaceuticals report). Firms in emerging economies are increasingly active in forming joint ventures with established multinationals or acquisition of companies in developed countries, with a view to gaining access to superior technology (chemicals and pharmaceuticals reports; Chari, 2009).

(ii) Econometric work

As in the studies on imports, most of the studies on the impact of FDI have focused on manufacturing sector.[22] Keller and Yeaple (2009) shows that spillovers from foreign multinationals to US firms (1987-96) within the same industry (horizontal spillovers), after controlling for the state of competition, can explain a substantial part of US manufacturing productivity growth, and such spillovers are strongest in high-technology industries, and within industries on those firms most distant from the productivity frontier. They also show that import-related spillovers are much weaker.[23] Foreign acquisitions can serve as a channel of technology transfer. Girma *et al.* (2007) finds a

20. This paragraph heavily draws on Keller (2009) pp. 28-30, 42.

21. Survey results show that “lower development costs” and “better access to local consumer insights” are the two most often cited reasons for MNEs for pursuing R&D in emerging economies. McKinsey & Co. (2011a).

22. See Keller (2009) pp. 34-41 for further literature survey.

23. The import here is measured as the import share in import plus shipments of an industry.

positive impact of acquisition by foreign multinationals on post-acquisition productivity of the newly acquired subsidiary, based on UK manufacturing firm (1988-96).[24]

Inward FDI can work in different ways depending on the income levels and the industry. Blalock and Gertler (2008) finds evidence for vertical-backward spillovers. It shows strong productivity gains, greater competition and lower prices among local firms in the sector that supply downstream foreign entrants, based on Indonesian manufacturing plants (1988-96). It further shows an externality that benefits other downstream industries that buy from the supply sector. In contrast, it finds no evidence of horizontal technology transfer.[25] They argue that horizontal spillovers are unlikely in the case of developing countries where the technology gap between foreign and domestic firms may often be wide, and multinationals may take measures to minimise technology leakage to local competitors; on the other hand multinationals have incentives to improve the productivity of their suppliers through training and other measures. Motohashi and Yuan (2009) compares the patterns of technology spillovers on local parts supply firms in China in the automotive and electronics industries. They find evidence of backward technology spillovers from multinationals in the automotive industry (a positive impact of R&D stock of multinational assemblers on value added of a local supplier), but not in electronics. They attribute this contrast to the difference in the characteristics of the industry, i.e. whereas close coordination between the supplier and the assembler is essential for automotives, modular architecture of the electronics industry makes such coordination unnecessary. In another study on FDI in China, based on province-industry level panel data in 2000-07, Ito *et al.* (2010) finds a positive spillovers from upstream production by foreign investors on productivity of downstream firms (forward linkages) but negative spillovers through backward linkages, and no evidence for horizontal spillovers.

On the impact of outward FDI, Griffith *et al.* (2006) show, among UK manufacturing firms in 1990-2000, a significantly higher productivity growth if they had an inventive presence in the United States prior to 1990 and operate in an industry with strong US R&D growth. Branstetter (2006) examined Japan's manufacturing FDI in the United State and found that knowledge spillovers go both from the investing Japanese firms to the local US firms and vice versa, based on the patent citation. Specifically, spillovers to the investing Japanese firms tend to be strongest via R&D and product development facilities, whereas spillovers from Japanese firms tend to flow most strongly through Greenfield affiliates.

Some studies go closer to innovation, beyond productivity. Guadalupe *et al.* (2010), based on Spanish manufacturing firms (1990-2006), show that foreign ownership leads to process and product innovation, and assimilation of new foreign technologies, implying that technology is being transferred from the parent to the subsidiary. They further find that the higher levels of innovation by foreign subsidiaries are driven by firms that export

24. The overall impact of M&A on post-merger performance may be ambiguous (pharmaceuticals report). See cf. McKinsey & Co. (2011b) (illustrating the integration efforts required after big acquisitions).

25. Javorcik (2004) similarly find evidence in favour of backward vertical spillovers, especially through contacts between foreign affiliates and their local suppliers in upstream sectors, but not horizontal spillovers, based on Lithuanian manufacturing firms in 1996-2000.

through a foreign parent, which suggests that foreign ownership facilitates access to larger markets and creates incentives to innovate. They show in addition a positive association between foreign ownership and productivity. Ito *et al.* (2010) examined the impact of FDI on patent applications based on Chinese data and, in contrast to their results on the impact on productivity (above), finds positive horizontal spillovers from R&D by foreign investors but no evidence for vertical spillovers. Finally, foreign acquisition may involve organisational innovation. Chari *et al.* (2009) analysed the impact of acquisitions made by firms located in emerging markets in 1980-2007 and shows that sales and employment decline while profitability rises in the years following the acquisition, suggesting significant restructuring of the target firms.

(c) Trade in technology

(i) Mechanism of diffusion through trade in technology

Trade in technology, such as through licensing of intellectual property,[26] is another channel of technology diffusion. Trade in technology improves the quality of innovation by increasing the pool of ideas (Spulber, 2008, 2010), and efficiency of innovation by encouraging a division of innovative labour and specialisation (Arora and Gambardella, 2010a). World Bank (2008) notes that licensing can be used as a substitute for FDI by multinationals, since uncertainty about the policy environment may lead them to sell technology rather than to exploit it through FDI.

As summarised in Onodera (2008), markets for technology are large and growing, albeit with significant sectoral variation: licensing is concentrated in the chemicals (including pharmaceuticals), electronic and electrical equipment (including semiconductors) and industrial machinery and equipment (including computers). An OECD survey further shows that increases in outward licensing are most frequently reported in the ICT sector, whereas increases in inward licensing are most likely in the pharmaceuticals.[27]

Licensing activities are highlighted in the chemicals and pharmaceuticals reports. SEFs have been instrumental in technology diffusion through licensing in basic industrial chemicals. Arora and Gambardella (2010b) notes “SEFs helped create a market for technology, making process technology into a commodity that could be bought and sold”. Licensing from biotech firms to pharmaceutical companies is increasingly prevalent in the pharmaceutical R&D process.[28] Arora and Gambardella (2010a) argue that, while in many sectors licensing is still not central to the innovation process, nor is it the dominant form of technology flows between firms, bio-pharmaceuticals (for innovation process) and chemicals and petroleum refining (for technology flows) are notable exceptions.

Trade in technology can take place in another form. Easterly (2002) reports the consequence of a collaborative agreement between Daewoo Corporation and Desh Garment Ltd. of Bangladesh in 1979, which included training of Desh workers at

26. IFPMR (2011) lists a number of examples of technology transfer from research-based pharmaceutical companies to firms in emerging economies.

27. OECD (2008b) pp. 70-72.

28. See World Bank (2008) for more case studies on the benefits of technology licensing.

Daewoo's Pusan plant in exchange for royalties and sales commission to Daewoo. Not only did the shirt production by Desh soar from 43 000 in 1980 to 2.3 million in 1987, 115 out of 130 workers trained by Daewoo left Desh to set up their own garment export firms during the 1980s, while the agreement was cancelled in 1981. Technology transferred from Korea diffused within the country, bringing about a highly successful garment industry in Bangladesh.

(ii) Econometric work

Although there are many fewer econometric studies on the relations between licensing and innovation, Gonçalves *et al.* (2007) analysed the firm-level data in Argentina and Brazil in the late 1990s, and found that acquisition of foreign technology through licensing and outsourcing plays a much more important role than in-house R&D spending for both product and process innovation. Nishimura *et al.* (2005) found evidence to support, based on Japanese firm-level data, that productivity growth comes not only directly from R&D activities but also indirectly from patent purchases and imports.

2. Competition effects

(a) Mechanism of competition effects on innovation

Trade can affect innovation through competition. Not only imports but also inward FDI and exposure to foreign market (by exports or outward FDI) as well as technology licensing (by facilitating entry; Arora and Gambardella, 2010a) can all foster competition. Generally, competition works in two distinct ways (Syverson, 2010). First, competition induces selection among producers with heterogeneous productivity levels and shifting market share toward more efficient producers and away from the less efficient. Second, competition affects the innovative efforts by individual firms, although this can work in two contrasting directions. On one hand, competitive pressure can work as an incentive for a firm to become more efficient (Arrow, 1962).[29] On the other hand, competition reduces the monopoly rents that induce a firm to invest in innovation (Schumpeter, 1942).[30]

These contrasting directions are not necessarily contradictory, however. First, the direction in which competition works may depend on the technology level of the entrant and the incumbent firm. Aghion *et al.* (2009) hypothesises that the threat of technologically advanced entry spurs innovation in sectors close to the technology

29. "It may be useful to remark that an incentive to invent can exist even under perfect competition in the product markets though not, of course, in the 'market' for the information contained in the invention. This is especially clear in the case of a cost reducing invention."

30. "The introduction of new methods of production and new commodities is hardly conceivable with perfect […] competition from the start. And this means that the bulk of what we call economic progress is incompatible with it. As a matter of fact, perfect competition is and always has been temporarily suspended whenever anything new is being introduced […] even in otherwise perfectly competitive conditions." (pg. 105)

frontier ("escape-entry"), while discouraging innovation in laggard sectors.[31] Second, the impact of competition may depend on the type of the rents that dissipates with it. Ten Raa and Mohnen (2008) emphasises the distinction between capital rents and labour rents given that it is the former that matters for R&D investment.

In addition, even if a firm seeks innovating in the face of competition, business literature has recognised heterogeneous nature of competition among industries, and two distinct sources of competitive advantage for the firms, i.e. cost leadership and differentiation (Porter, 1980). Depending on the strategic choice by the firm, the foci of innovation can vary among firms; firms may focus on process innovation if they seek cost leadership, whereas they may focus on product innovation if differentiation is their source of competitive advantage (chemicals report). This means that innovative responses by firms facing competition is not limited to product innovation or R&D investment, but may involve introduction of new business models less reliant on product innovation.[32]

Competition is one of the key driving forces of innovation both in the chemicals and pharmaceuticals. Product innovation is considered the key to the company performance in speciality and fine chemicals in the face of the increased competition and acceleration of technology cycles. Competition in pharmaceuticals has become much more intense with greater presence of generic drugs and in-patent substitutes, and globalisation has been one of the answers of pharmaceutical companies, in terms of R&D process and of the market reach, which involves innovation of all types (product, process, marketing, organisational).

Onodera (2008) reports cases of competition-induced innovation. Fierce competition in DRAMs and other products in the early 1980s led Intel to focus on microprocessors, where they established their position in the PC market with its successive introduction of innovative products. The Sri Lankan garment industry initiated innovation such as introduction of new products, new process technologies and new brands, in anticipation of the scheduled import liberalisation and to differentiate themselves from low cost producers abroad such as China or India.

Bugamelli and Schivardi (2010) studied the impact of the euro on Italian firms and, based on interviews with Italian entrepreneurs, they find "[a]ll the firms that were surviving or even prospering in the globalized economy offered products that had a certain degree of differentiation and thus escaped pure cost competition". More specifically, they find that successful firms invest in broadly three types of activities: "upstream" activities such as product creation (R&D, design) and brand establishment (advertising, marketing), "auxiliary" activities such as organization of production, often partly or wholly outside the firm (through outsourcing and offshoring), generally based

31. Based on this idea, Aghion *et al.* (2005) predicts that sector level relationship between the level of competition and innovation is inverse-U. In Aghion *et al.* (2005, 2009), innovation is primarily measured by patents.

32. The example of Dow Corning illustrates these two distinct strategies. It divides its products into two brands; traditional Dow Corning offering customers speciality silicones backed by technical support and R&D, and Xiameter, an on-line managed, low cost sales channel for its commodity items (McKinsey & Co., 2011c). The latter is a new business model introduced in 2002, although it does not involve product innovation, it does represent process, marketing and organisational innovation.

on an intensive use of ICT, and "downstream" activities such as sales network, post-sales assistance.

(b) Econometric work

Many studies that used micro data, again on manufacturing sector and trade in goods, provide evidence consistent with the idea that trade liberalisation leads to a shift toward more efficient firms, including through exit of inefficient firms, and that firms surviving improve their productivity such as Pavcnik (2002) (Chilean firms, 1979-86), Eslava *et al.* (2009) (manufacturing plants in Colombia, 1982-98) and Trefler (2004) (the impact of CUFTA). Fernandes (2007) also supports these results, based on a sample of manufacturing plants in Colombia (1977-91), while also suggesting possible that the TFP gains under trade liberalisation may be linked to increases in intermediate inputs' imports, skill intensity and machinery investment. On the impact of inward FDI, Aghion *et al.* (2009) used a panel of 5 161 establishments and 174 firms in the United Kingdom in 1987-93 and confirms that entry of (technologically advanced) foreign firms triggers subsequent productivity growth and product innovation (measured by patent counts) among incumbents, but it can discourage them in industries that are far from the frontier.

More studies look closely into the implications of competition on innovation, all point to a positive impact of trade-induced competition on innovation, although results are mixed about whether distance from the "frontier" matters or not. Amiti and Khandelwal (2009) analysed the US import data at the product level and finds that lower tariffs are associated with quality upgrading (estimated from export prices and market share) for products close to the world frontier (maximum quality in the world market), while discouraging quality upgrading for varieties distant from the frontier. Fernandes and Paunov (2010) shows that stronger import competition (industry-level transport costs), together with better access to inputs, leads to significant quality upgrading (firm-product level unit value) by Chilean firms (1997-2003). Based on surveys in 27 transition countries in 2002 and 2005, Gorodnichenko *et al.* (2010) finds a positive relationship between foreign competition and innovation (product and process), both in manufacturing and services, and without regard to the distance from the productivity frontier. Bloom *et al.* (2011) shows that import competition from China led to technology upgrading (R&D intensity, patenting, IT intensity and TFP) within firms, and that employment shift towards more innovative and technologically advanced firms, using a firm level panel in manufacturing across twelve European countries (1996-2007). Finally, based on a sample of 732 medium-sized manufacturing firms in the United States, the United Kingdom, France and Germany, Bloom and van Reenen (2007) finds a strong association between higher levels of competition (such as trade openness[33]) and better management practices (scored on the basis of survey results). As well, better management practices are significantly associated with higher performances (such as productivity and profitability).[34]

33. Openness is measures as industry level (ISIC-2) imports per output.

34. See also Bloom and van Reenen (2010) for more about product market competition and management practices across countries.

3. The role of exports

(a) Mechanism of exports and innovation linkages

It is firmly established that exporters are more productive and more innovative[35] in a broad range of countries. Much less well established is the causal linkage: on one hand, productive firms may self-select into export market;[36] on the other hand, exporting may make firms more productive (learning-by-exporting) (Wagner, 2007; Bernard, 2007; Keller, 2009; WTO, 2008a). These channels are not mutually exclusive, or may even be interdependent. The causal links may depend on the size of the domestic market (Lileeva and Trefler, 2010). These pose a challenge to statistically identify the causation.[37]

There are a number of reasons to believe in the learning-by-exporting: (a) possibility of technical assistance from overseas buyers, (b) better access to knowledge about more advanced production technologies, (c) higher quality standards in international markets, (d) faster learning about market opportunities for new products and (e) higher capacity utilisation by expanding sales (Park *et al.*, 2010). Even so, many studies tend to lean towards the self-selection hypothesis, while evidence in favour of the learning-by-exporting hypothesis has been mixed (Wagner, 2007).

It is noteworthy that these different channels of learning-by-exporting may work differently in different sectors.[38] For example, information relating to quality upgrading and new product development may be important for sectors where product differentiation is important, such as speciality and fine chemicals, consumer chemicals or branded apparels, but it may not be the case for standardised commodities such as basic industrial chemicals (chemicals report). Technical assistance from buyers may be present in automotives, but may not be in electronics (Motohashi and Yuan, 2009).[39] Nevertheless, sector specific studies studying the importance of these channels are not very common.[40]

On the other hand, the pharmaceuticals report highlighted the importance of exports not for reasons of "learning", and above all that profit opportunities arising from access to

35. OECD (2009) Figure 1.8 shows that the share of innovative firms are substantially higher among firms operating internationally than among those operating on domestic markets only in most of the OECD countries. Almeida and Fernandes (2008) shows that exporting, importing and foreign ownership is associated with higher probability of engaging in technological innovation among developing countries.

36. The proposition is underpinned by a theoretical model with heterogeneous firms in Melitz (2003).

37. The same issue of causation is also present in imports, as discussed above. See also Bernard *et al.* (2007).

38. Lileeva and Trefler (2010) suggests that this is due to the size of the domestic market

39. Freeze (2007) provides a case study from an innovation in textile machine in former Czechoslovakia in the 1960s and the roles of inputs from a user (Courtaulds Ltd in the United Kingdom) and a licensee of marketing rights (Toyoda Automatic Loom Works in Japan) in achieving a breakthrough, which resulted in its successful exports in broader European and US markets.

40. Aw *et al.* (2010) may be the only exception, which focused on electronics sector in Chinese Taipei.

foreign markets provide the necessary financial resources and incentives to invest in costly R&D to develop new drugs. Many econometric studies focusing on pharmaceuticals identify current and future profits as the key determinants of R&D investment, although typically they do not explicitly use exports to explain R&D investment.

Furthermore, entering new foreign markets often requires innovation, including non-technological types.[41] For example, when consumer chemicals companies and pharmaceutical companies from developed countries enter emerging markets, they need to develop and implement innovative marketing methods which are suitable to the local conditions.[42] When Indian pharmaceutical firms deal with foreign clients or export to developed country markets, they may need to upgrade their practices in compliance with the regulatory standards (e.g. good laboratory practice, good clinical practice). Furthermore, such innovation effort may be required not just in exporting but also in more general expansion of operations, including FDI. When pharmaceutical companies extend the geographical reach of their R&D process, they often re-organise their research departments (chemicals report, pharmaceuticals report).

(b) Econometric work

Notwithstanding the general scepticism toward positive role of exports on innovation, the most recent literature emphasises the complementarities of exporting and innovating activities. Improved access to foreign markets effectively increases the size of the market, which induces firms to simultaneously export and invest, and these joint decisions lead to productivity gains. To test this mechanism, Lileeva and Trefler (2010) examined the responses of Canadian plants to the elimination of US tariffs under the CUSFTA, and find increased labour productivity, more product innovation (rather than process innovation) and higher adoption rates for advanced manufacturing technologies, by Canadian plants that were induced by the tariff cuts to start exporting or to export more.

Bustos (2011) analysed the impact of tariff reduction by Brazil under MERCOSUR on Argentinean firms (1992-96) and finds (a) firms in sectors with a higher tariff reduction are more likely to enter the export market, (b) firms increase their spending on technology (e.g. spending on computers and software, payments for technology transfers and patents) faster in industries where tariffs fall more, and (c) the effect of tariffs is highest in the middle sized firms. Thus, increased revenue from exports due to trade liberalisation induces upgrading of technology, in particular by those exporters which have not adopted high technology but become capable of doing so by increased revenue by exports (i.e. middle-range firms). Aw *et al.* (2011), based on the data for manufacturing plants in the electronics products industry in Chinese Taipei (2000-04), find that export market expansion, such as due to trade liberalisation, increases participation rates in exporting and R&D investment, both of which contribute to productivity improvement, including through the learning-by-exporting effect.

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41. McKinsey & Co. (2011d) illustrates how growth can induce significant organisational changes.

42. See e.g. Verhoogen (2008) (showing that exporting driven by the late-1994 peso crisis in Mexico led to increases in ISO 9000 certification and blue-collar schooling, which are taken as corroborative evidence for the quality-upgrading).

Other recent studies have sought to find evidence on "learning" to connect exporting and productivity growth. De Loecker (2007) used micro data of Slovenian manufacturing firms in 1994-2000, a period of drastic changes in trade orientation for the country, and finds that export entrants become more productive once they start exporting, and the productivity gap between exporters and non-exporters expands overtime. It also finds that productivity gains are higher for firms exporting towards high income regions, which is consistent with learning from buyers. Park *et al.* (2010) find similar results, based on the Chinese industrial census data around the period of the Asian financial crisis (1995-2000).

Survey data that cover both manufacturing and non-manufacturing firms are also used to more directly observe the learning process by the firms. Crespi *et al.* (2008b) find that firms who exported in the past are likely to learn more from clients than other sources, and firms who learned from clients in the past are more likely to have faster productivity growth, based on the UK Community Innovation Survey in the late 1990s. Yashiro *et al.* (2010) used a customised survey of Japan's small and medium enterprises in 2009 and showed that gathering information from foreign markets, in particular latest foreign technology and products, alongside R&D after exporting, significantly raises the probability of product upgrading or new product developments by exporters.

IV. Policy Issues

1. Absorptive capacity

The extent to which a firm benefits from international technology diffusion to foster its productivity and innovation depends also on the technological absorptive capacity of the firm and of the economy, such as the skill levels of the workforce and R&D capacities.[43] World Bank (2008) further emphasises that absorptive capacity depends not only on basic technological literacy but also on broader contributors such as governance and the business climate (such as political and macroeconomic stability, and quality of regulation and legal environment) and government actions that help overcome market failures, including supporting R&D and building infrastructure.[44] Thus, there are a broad

43. Econometric studies on the positive role of absorptive capacity in technology diffusion from imports, see Augier *et al.* (2010) (firm-level, manufacturing firms in Spain, 1991-2002), Eaton and Kortum (2001) (cross-country, 34 countries, 1985), Dulleck and Foster (2008) (cross-country, 55 developing countries, 1960-99), and Liu and Buck (2007) (sub-sector-level data in China, 1997-2002, including diffusion from imports, exports and R&D by MNEs). Mancusi (2008) (cross-country, 14 OECD countries, 1978-2003) shows a positive role of absorptive capacity based on patent data, and Girma *et al.* (2007) based on productivity after acquisition by foreign multinationals (UK manufacturing firms, 1988-96).

44. A cross-country study by Coe *et al.* (2009) find that countries that are relatively easy to do business benefit more (in terms of productivity) from international R&D spillovers as well as their own R&D efforts. Krishna *et al.* (2010) emphasises the importance of infrastructure development (e.g. ports, roads and communication links) to benefit from trade. *See also* Stone and Shepherd for the gains from imports and complementary policies.

range of policy agendas in order for the firms and the economy as a whole to better benefit from technology diffusion.

Learning capabilities are inherently different across firms. Apart from technological factors such as R&D, Criscuolo *et al.* (2010) suggests that "globally engaged firms" (exporters, or parents or affiliates of multinationals) do learn better (i.e. make more effective use of information to innovate) internally (within the firm or the group) or externally (especially customers and suppliers). While this study leaves open whether these firms become better at learning or those that use information better go global, it may well go both ways: their learning capabilities leave them globally engaged and by doing so they learn more effectively than others from their global engagement.

Capacity to take up technologies ultimately manifests itself in productivity levels. Acemoglu and Ziliboti (2001) argue that even if developed countries and less developed countries have access to the same technologies, the mismatch between the skills of the less developed countries and technologies imported from developed countries is an important source of the productivity gap across countries.

In the case of the growing presence of emerging economies in the chemicals and pharmaceuticals, while working with foreign companies, such as licensing from SEFs in the chemicals sector or collaboration in the R&D process in the pharmaceuticals sector, has played a significant role, their own R&D investment and large talent pool[45] are essential to benefit from technology diffusion. In terms of product innovation in specialty chemicals, Arora and Gambardella (2010b) documents cases where new advanced materials diffuse only slowly. At a firm level, users need to learn about the properties of the new materials (e.g. rayon fibres before World War II), and at a broader level, concomitant changes may be needed in the physical infrastructure (e.g. fuelling stations for automobiles with fuel cells).

An interaction between trade liberalisation and absorptive capacity can also be found in a case study on the South African agriculture sector (Sundrey and Vink, 2008). Onodera (2008) attributes the limited innovation in response to trade liberalisation in some agricultural sectors in South Africa to absorptive capacity in a broad sense in the country, such as a government policy designed to reduce unemployment that is at odds with the introduction of new technologies, risk of land redistribution and shortcomings in terms of transport infrastructure and electricity.

The relative decline of the Japanese IT industry in the 1990s in Arora *et al.* (2010) is illustrative of how broad business environment may affect long-term competitiveness of an industry. The study suggests that the increasing dependence of IT innovation on software keeps Japanese firms from responding adequately to the shift and deteriorates their performance. To account for this, they point to significant resource constraints in Japan compared with the United States, citing the inadequate supply of skilled software labour and barriers to bringing foreign expertise, due in part to its immigration laws. Yet they do not rule out the possibility of the second hypothesis, managerial myopia,

45. India produces nearly 150 000 chemistry graduates per year, and 120 000 undergraduate. 120 000 graduate students in China are estimated to be enrolled for chemistry each year, 120 000 for medical sciences, and 60 000 for biological sciences (KPMG International [2009] pg. 19).

reinforced by the practice of lifetime employment and internal promotion of managerial postings.[46]

Finally, World Bank (2008) notes that rules on entry and exit as well as labour market flexibility are among the elements of absorptive capacity since they can impede technological progress by limiting the expansion and creation of innovative firms while keeping inefficient firms in the market. Indeed, many empirical studies reviewed in Section III find that opening up to trade leads to substantial aggregate productivity gains not only through productivity gains in individual firms but also through reallocation of output from less efficient to more efficient firms which involves growth of more efficient firms and contraction or exit of less efficient firms (Pavcnik, 2002; Fernandes, 2007; Eslava *et al.,* 2009; Trefler, 2004).[47] Such adjustment can be obstructed by industrial licensing and rigid labour laws (Goldberg *et al.,* 2010). It is also noteworthy that not only closure but also M&A is an important exit strategy (Breinlich, 2008; Greenaway *et al*., 2008). Thus, the regulatory framework, including labour law, industry regulation and entry and exit procedures, that facilitates adjustment following trade liberalisation are important for the economy-wide productivity improvement.

2. Trade liberalisation

The empirical studies reviewed in the previous section point to the importance of liberalisation in trade, investment and licensing. There may be complementarities between trade liberalisation and broader liberalisation measures. Topalova and Khandelwal (2011) shows that the effect of trade liberalisation was magnified by liberalisation of FDI and removal of licensing requirements in India.[48]

The rest of this sub-section will discuss tariff liberalisation and technical regulation in more details.

(1) Tariff liberalisation

While it is often pointed out that the importance of tariffs as trade barriers has been reduced as a result of successive rounds of tariff reductions under the GATT (cf. OECD, 1998), as well as unilateral tariff liberalisation initiatives (Baldwin, 2010) and widespread regional trade agreements (RTAs), there still remain substantial tariffs in several sectors. This is also the case with the three sectors reviewed in the sectoral studies (chemicals, pharmaceuticals, ICT), all of which were subject of sector-specific tariff negotiations during and after the Uruguay Round, both in the way that these arrangements were designed and due to the subsequent rise of emerging economies in trade in these products.

46. This study refers the second factor (managerial myopia) as absorptive capacity, but the first factor (resource constraints) can also be related to absorptive capacity in a broad sense.

47. See Bernard *et al.* (2007) pp. 112-14 for additional survey on productivity growth through reallocation.

48. The licensing of industries required when establishing a new plant, expanding capacity and introducing a new product was one of the most important tools to control private enterprises in India. Topalova and Khandelwal (2011), note 30.

In terms of the designs, the Chemicals Tariff Harmonisation Agreement (CTHA), a part of the results of the Uruguay Round, harmonised the tariff levels among the participants to this agreement, rather than eliminating them. The Information Technology Agreement (ITA), despite its broad coverage of ICT goods, tariff elimination on additional goods is explicitly left to future negotiations, which indeed started just after the conclusion of the ITA ("ITA 2"), although the process has not come to its fruition.[49]

The rise of emerging economies in world trade can be observed in the list of top traders in these three sectors. At an aggregate level, too, in all three sectors, trade between high income countries has declined since the mid-1990s, albeit by varying degrees, and trade involving low and middle income countries has significantly expanded.[50] Given that the emerging economies have not participated in these sectoral tariff arrangements in many cases,[51] these non-participants are not bound by these arrangements in setting their duties. Emerging economies now occupy a sizeable portion of import duties collected worldwide in these sectors, even after accounting for tariff reduction beyond bound tariffs, due to unilateral initiatives or to RTAs.

Although tariff reductions by virtue of unilateral initiatives or bilateral or RTAs are important, there are both legal and economic case for multilateral route. On the legal side, the fact that these reduced rates are not bound under the GATT means that they can be raised to the bound tariff rates, typically much higher in many emerging economies, although this was generally not the case even during the financial crisis of 2008-09 (WTO, 2010).[52] On the economic side, multilateral tariff cuts can magnify the effect by lowering import prices through domestic tariff cuts that are matched by cuts abroad (Feenstra *et al.*, 2009). The multilateral route also provides exporting firms with opportunities to gain from exports, fostering innovation efforts and learning-by-exporting. Finally, multilateral liberalisation can ensure the lasting effect of enhanced competition, since, as Melitz and Ottaviano (2008) theoretically shows, pro-competition effects by unilateral liberalisation can be reversed in the long run by relocation of firms to non-liberalising countries, thereby reducing competition.[53]

These remaining tariff issues have explicitly been negotiated during the Doha negotiations. Beyond tariff reductions by a Swiss formula that will apply to developed

49. In contrast, additions of products have been successfully done in pharmaceuticals. This involves much smaller group of WTO members than is the case with the ITA, and the process is based on the agreement among industries in major participants to the negotiations. See pharmaceuticals report for more descriptions.

50. WTO (2008a) Chart 2 shows the shares of industrial countries in world manufacturing exports by product group (1995-2006), including automotive products, textiles and clothing, all of which exhibit declining trends.

51. The ITA has much broader participation than pharmaceuticals and chemicals arrangements do, with the participation of emerging economies such as China and India.

52. Quantitative studies also conclude that much of "trade collapse" can be explained by the decline in demand, especially in heavily trade goods, rather than protectionist trade policy measures. See OECD (2010c) and Eaton *et al.* (2011). However, the latter also points out that there are some countries whose decline in trade cannot be explained by demand alone, in particular China and Japan.

53. See Chen *et al.* (2009) for empirical evidence.

countries and emerging economies,[54] negotiating proposals that aim at tariff elimination in the chemicals sector, the electronics/electrical sector (which includes the ICT sector) and the healthcare sector (which covers pharmaceuticals and medical devices) have been tabled by interested WTO members.[55] Following the example of the ITA, but unlike the sectoral tariff elimination arrangements in the Uruguay Round, they all require a critical mass of participation, such as participation by the members that collectively represent 90% of world trade in the products covered by the initiative. This practically means that participation by at least some of the emerging economies is required for these proposals to be effectively incorporated in the results of the Round. The sectoral negotiations have, in reality, been a particularly difficult issue in the negotiations.[56]

(2) Technical regulations

Regulations can affect trade and innovation in multiple ways. First, they can work as non-tariff barriers to trade and foreign direct investment (Conway *et al.*, 2006) and limit competition, while they can also reduce trade costs because compliance with technical standards conveys information on product characteristics such as compatibility or interoperability (Portugal-Perez *et al.*, 2010).[57] Second, they can negatively affect the rate of innovation by imposing additional burdens on innovation, and they can also affect the direction of innovation by changing the incentives of the innovators in a socially desirable direction, which may in turn contribute to the competitiveness of the innovators (the chemicals report, pharmaceuticals report). Third, the broader regulatory environment can affect the firms' capacity and incentives for new technology adoption (Conway *et al.*, 2006; World Bank, 2008), which is related to absorptive capacity as discussed above.

In order to ensure that technical regulations and standards do not create unnecessary obstacle to international trade, while recognising the policy objectives of the protection of human, animal or plant life or heath, or of the environment, the WTO's Agreement on Technical Barriers to Trade (TBT Agreement) lays out, among others, a notification procedure for technical regulations when a relevant international standard does not exist and if the technical regulation may have a significant effect on the trade (Articles 2.9 and 5.6). The meetings of WTO's Committee on Technical Barriers to Trade discuss a range of TBT measures, including, in particular, the issues involving the chemicals sector (chemicals report).

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54. According to the current NAMA text, not all developing countries are subject to formula reduction (WTO, 2008b).

55. The latest proposals are contained in WTO (2008a), note 54.

56. WTO (2011).

57. Conway *et al.* (2006) find that, among 21 OECD countries (1978-2003), anti-competitive product regulation is particularly harmful for technology-driven productivity improvements in ICT-intensive sectors, and well-functioning product markets are an important condition for rapid productivity catch-up. The study also shows that such anti-competitive regulatory environment curbs ICT investment and discourages the establishment of foreign affiliates and their propensity to increase employment, which may together constitute as transmission channels of the impact of regulation on productivity.

The TBT Agreement generally focuses more on non-discrimination between imported goods and domestic goods, and little to do with the substance of regulations (Staiger and Sykes, 2009).[58] Differences in regulation and duplication of regulatory procedures among trading partners can become significant impediments to trade. In pharmaceuticals, for example, in order to mitigate such negative impacts of regulation, there are a number of co-operation schemes between regulatory authorities, beyond the disciplines under the TBT Agreement. These include (a) harmonisation of safety testing procedure ("Good Laboratory Practice [GLP]") and mutual acceptance of data (MAD) generated by this procedure under the OECD, (b) harmonisation of inspection procedures and standards in the field of manufacturing of medicinal products ("Good Manufacturing Practice [GMP]") under the Pharmaceutical Inspection Co-operation Scheme (PIC/S) or bilateral mutual recognition agreements (MRAs), and (c) regulatory harmonisation on broader regulatory agendas under the International Conference on Harmonisation of Technical Requirements for Registration of Pharmaceuticals for Human Use (ICH). Among them, the OECD's MAD system covers industrial chemicals and pesticides as well as pharmaceuticals, and the net annual cost savings with respect to industrial chemicals and pesticides by this system is estimated to be 153 million euros (OECD, 2010d). In each forum, partnership with emerging economies is being sought to extend the geographical reach of these schemes.[59]

Technical barriers to trade are also important for the ICT sector. OECD (2002) lists four major types of regulation on ICT products: EMC (electromagnetic compatibility), electrical safety, protection of public telephone networks, and avoidance of radio interference and effective use of spectrum. It points out that delays in the introduction of new products due to differing standards and duplicative conformity assessment regimes across countries is the biggest concern for the industry given the increasingly shortened cycles of ICT products. Additional production costs for telecommunication equipment to meet different technical specifications in different export markets estimated in OECD (2000a) put the typical figures at 5% or less, although it could be up to 10%. OECD (2000b), analysing electrical products and electromagnetic compatibility, cites an estimate by industry that global regulatory cost could exceed USD 50 billion per year.[60] Portugal-Perez *et al.* (2010) shows a positive impact of EU standards aligned with international standards (IEC [International Electrotechnical Commission] standard) on trade flows of electronic products.[61] The issue of EMC as it concerns the negative impact on trade due to differing conformity assessment requirement has been taken up by the

58. TBT Agreement Art. 2.4 states "[…] Members shall use [international standards], […], as a basis for their technical regulations except when such international standards or relevant parts would be an ineffective or inappropriate means for the fulfilment of the legitimate objectives pursued […]." This may be viewed as a provision more pertinent to the substance of the regulation, although limited by exception. *Compare* Staiger and Sykes (2009) pp.40-41 and Trachtman (2006) pp.480-81.

59. IFPMA (2011) points out, on the pharmaceuticals sector, "[t]he ability to meet international regulatory standards, or at least those of the major markets, is a precondition for many technology transfer activities."

60. See also Klimenko (2009) (analysing the welfare cost due to network externalities of the products concerned, such as ICT goods).

61. Current state of technical regulations on ICT/Telephony and their links to international links are surveyed in Fliess *et al.* (2010).

WTO's ITA Committee, which developed "Guidelines for EMC/EMI Conformity Assessment Procedures" in 2005, although specific solutions have yet to be worked out (ICT report, Part 1).

Since global markets can be segmented by the standards adopted in a country, domestic standard setting can have a lasting impact on the domestic industry. Nokia benefited as a very early adopter of what would develop into the Global System for Mobile (GSM) standard, which further became the pan-European standard in the mid-1990s (Lesser, 2008). Samsung was able to develop its capabilities in the domestic and foreign Code Division multiple Access (CDMA) markets, which were very important for Samsung to move into the far larger GSM market (Onodera and Kim, 2008; see also Jho, 2007). In contrast, the Japanese industry failed to benefit from the global surge in handset demand, mainly because of differences in telecommunications standards and the industry's focus on the relatively large domestic market (Onodera, 2008).

The issue of technical barriers to trade has been extensively discussed in the current DDA negotiations. Sector-specific negotiating proposals are being tabled with respect to automotives, chemicals, electronics (on electrical safety and electromagnetic compatibility [EMC]), and textiles, clothing, footwear and travel goods (on labelling requirements). Except for the last one, two proposals are on the table for each sector with differences on certain key issues, such as clarification of international standards, disciplines on conformity assessment procedure (automotives, electronics), and disciplines on registration requirements (chemicals).[62]

3. Protection of intellectual property

The general role of the protection of intellectual property, either by patents, secrecy or other means, has been thoroughly discussed (e.g. OECD, 2010b). In particular, patents are extensively used in many high-technology industries (*ibid*.). Many studies have highlighted some important differences in how patents work across sectors, especially

62. WTO (2010), *Agreement on Non-Tariff Barriers Pertaining to Standards, Technical Regulations,and Conformity Assessment Procedures for Automotive Products*, Communication from the European Union, TN/MA/W/118/Rev.2, 23 June 2010; WTO (2010), *Understanding on Non-Tariff Barriers Pertaining to Standards, Technical Regulations, and Conformity Assessment Procedures for Automotive Products*, Communication from Canada and the United States, TN/MA/W/139, 9 July 2010; WTO (2010), *Understanding to facilitate the implementation of the TBT Agreement as applied to trade in the chemical products sector*, Communication from Argentina, Brazil and India, TN/MA/W/135/Rev.1, 4 August 2010; WTO (2010), *Understanding on Non-Tariff Barriers Pertaining to Standards, Technical Regulations and Conformity Assessment Procedures for Chemical Products*, Communication from the European Union, TN/MA/W/137/Rev.1, 23 June 2010; WTO (2010), *Understanding on the Interpretation of the Agreement on Technical Barriers to Trade as Applied to Trade in Electronics*, Communication from the European Union, TN/MA/W/129/Rev.1, 23 June 2010; WTO (2010), *Negotiating Text on Non-Tariff Barriers Pertaining to the Electrical Safety and Electromagnetic Compatibility (EMC) of Electronic Goods*, Communication from the United States, TN/MA/W/105/Rev.3; 26 November 2010; WTO (2011), WTO (2010), *Understanding on the Interpretation of the Agreement on Technical Barriers to Trade with respect to the Labelling of Textiles, Clothing, Footwear, and Travel Goods*, Communication from the European Union, Mauritius, Sri Lanka, Ukraine and the United States, TN/MA/W/93/Rev.2, 8 November 2010.

chemicals and pharmaceuticals on one hand, and ICT/electronics industries on the other. First, it is relatively easier to specify the technology to be protected in the chemicals and pharmaceuticals, which makes patent protection stronger and licensing of technology easier, whereas such articulation is much harder in electronics and computers (Anand and Khanna, 2000). Second, underlying technologies for typical new drugs or chemicals are a relatively discrete number of patentable elements, while a much larger number of patentable elements are involved for electronic products, and firms often lack control over all the essential complementary components of at least some of the technologies they are developing, which encourages them to enter into negotiations for cross-licensing (Cohen *et al.*, 2000). Third, it is much easier to free-ride on the information generated by R&D in chemicals and pharmaceuticals for imitators without protection, although imitation is much harder in most other industries since imitators need to duplicate much of the R&D themselves to commercialise (Scherer, 2000). Finally, the technology lifecycle in ICT/electronics industries is much shorter than in pharmaceuticals and firms can get around patents that quickly render the existing patents obsolete, making the value of IPR protection very different between these two sectors (Ernst & Young, 2010; OECD, 2008b).

It is widely recognised that the intellectual property legislation and enforcement has much strengthened worldwide in recent years, and empirical studies indicate that this has improved international technology diffusion, although the situation is not without problems in some emerging economies. The pharmaceuticals report illustrated the impact of stronger patent protection in conjunction with the introduction of the Agreement on Trade-Related Aspects of Intellectual Property Rights (TRIPS Agreement) in upgrading the R&D capability in emerging economies. It shows that the introduction of product patents on pharmaceuticals following adoption of the TRIPS Agreement has prompted top-performing domestic firms to intensify their R&D activities in India and Brazil, and that it has given incentives for multinational firms to introduce new drugs to these emerging markets, such as India. Cross-country studies suggest that patent protection is positively associated with pharmaceutical innovation, FDI,[63] pharmaceutical imports, clinical trial locations, and cross-border collaborations.[64]

Studies suggest that patent protection not only work as a vehicle of licensing deals by reducing transaction costs (Arora and Foscuri, 2003; Antràs *et al.*, 2009), but it also facilitates technology transfer through trade and FDI. A cross country study by Park and Lippoldt (2008) supports the positive association between patent protection and inward FDI, merchandise imports and service imports. Branstetter *et al.* (2006) shows, based on affiliate-level data of US multinationals in the 1980s and the 1990s, that improvements in IPR protection result in real increases in technology transfer within multinational enterprises. Wakasugi and Ito (2009) similarly find a positive effect of patent protection on intra-firm technology transfer based on a sample of Japanese multinationals in 1995 and 2001. Branstetter *et al.* (2011), using similar data as Branstetter *et al.* (2006), finds

63. Qian (2010, 2007) emphasises the complementary roles of income levels, education and economic freedom.

64. IFPMA (2011) lists protection of IP as one of the "right conditions" for pharmaceutical technical transfers, alongside other conditions such as market scale and accessibility, political stability and good, transparent governance and adherence to high regulatory standards.

evidence suggesting that stronger IPR in developing countries accelerates the transfer of production to IPR reforming countries.

On the linkage between patent protection and trade flows, Ivus (2010) finds that stronger patent rights raised the value of patent-intensive exports from developed countries to developing countries, rather than hindering access to innovative goods by the latter. Coe *et al.* (2010) show that countries with stronger patent protection tend to benefit more from a given level of domestic and, to a lesser extent, foreign R&D capital through trade, although the authors acknowledge that the size of the impact in their estimation is not very large.

V. Concluding remarks

This paper, together with other previous studies on trade and innovation for the Trade Committee, provides evidence that trade is one of the important factors that drives innovation. First, imports and FDI are among the central conduits of international technology diffusion, either through supply chains or due to interactions among competitors. Trade in technologies, including through licensing, is also an important channel of technology diffusion, albeit with different degrees in different industries. Second, trade, FDI and licensing can all affect the conditions of competition in the domestic market. While the impact of competition on innovation by individual firms can logically be either positive or negative, a number of studies suggest that competition can have a positive impact on innovation, some suggesting that it is only for technology leaders. Studies generally agree that trade-induced competition improves economy-wide productivity levels. Third, there is budding evidence to support the view that exports improve productivity of exporting firms, either through complementary contributions by exports and innovative efforts, or through learning-by-exporting, even if others have questioned such positive effects.

In terms of policy implications, the following points should be highlighted:

1. In order to ensure the benefits from international technology diffusion, absorptive capacity in a broader sense is very important, as it determines the extent to which the firm and the economy benefit from the technologies made available through such diffusion channels. Absorptive capacity in a broader sense depends not only on basic technological literacy and R&D capacity but also on political and macroeconomic stability, quality of regulation and other government actions targeting market failures. This goes well beyond the narrowly defined trade policy agenda, and echoes the OECD Innovation Strategy which advocates an approach which takes into account the interplay of different policy domains.

2. In terms of trade liberalisation, tariffs still represent substantial trade barriers in some cases, despite successive rounds of multilateral negotiations including sectoral tariff elimination/harmonisation arrangements from the Uruguay Round and the ITA in 1996. There have also been widespread initiatives of unilateral and regional tariff liberalisation in recent years. Nonetheless the value of further multilateral tariff liberalisation is both legally and economically compelling, and the Doha negotiations provide WTO members an opportunity to foster these links between trade and innovation.

3. Technical barriers to trade are important in many sectors, including the three sectors reviewed in recent studies for the Trade Committee (ICT, chemicals and pharmaceuticals). While the TBT Agreement lays down concrete disciplines especially to ensure non-discrimination, a number of co-operation schemes among regulatory authorities are in place in pharmaceuticals to alleviate regulatory burdens. For other sectors, the Doha negotiations have also provided an opportunity to consider sector-specific negotiating proposals that are intended to go beyond the TBT Agreement.

4. Intellectual property protection is important not just for innovation but also for international technology diffusion through various channels. The state of protection of intellectual property has improved in recent years, although it has been pointed out that some problems remain in some countries. Ensuring protection of intellectual property remains an important policy issue.

Looking forward, even though econometric studies based on firm-level data have provided important insights into various trade and innovation linkages in recent years, there is more to be done to clarify the diverse nature of such linkages. As has been observed in the studies including those undertaken for the Trade Committee, such linkages tend to vary depending on the nature of the sectors, the levels of technological capacity and the regulatory environment. Moreover, given that most f the studies reviewed in this paper are focused on the manufacturing sector, exploration into services sectors would represent fertile ground for new insights.

References

Abramovsky, Laura and Rachel Griffith (2006), "Outsourcing and Offshoring of Business Services: How important is ICT?", *Journal of European Economic Association*, Vol. 4, No. 2-3, MIT Press, Cambridge.

Acemoglu, Daron (2002), "Directed Technical Change", *The Review of Economic Studies*, Vol. 69, No. 4, Wiley Blackwell, Hoboken, pp. 781–809.

Acemoglu, Daron and Fabrizio Zilibotti (2001), "Productivity Differences", *Quarterly Journal of Economics*, May 2001, MIT Press, Cambridge.

Acharya, Ram C. and Wolfgang Keller (2009), "Technology Transfer through Imports", *Canadian Journal of Economics*, Vol.42, No.4, Canadian Economics Association, Montreal, pp. 1411-48.

Aghion, Philippe, *et al.* (2005), "Competition and Innovation: an inverted-U relationship", *Quarterly Journal of Economics*, May 2005, MIT Press, Cambridge.

Aghion, Philippe, *et al.* (2009), "The Effects of Entry on Incumbent Innovation and Productivity", *Review of Economics and Statistics* Vol. 91, No. 1, MIT Press, Cambridge, pp. 20-32.

Aker, Jenney C. and Isaac M. Mbiti (2010), "Mobile Phones and Economic Development in Africa", *Journal of Economic Perspectives*, Vol. 24, No. 3, Summer 2010, American Economic Association, Pittsburgh, pp. 207-32.

Almeida, Rita and Anna Margarida Fernandes (2008), "Openness and Technological Innovations in Developing Countries: Evidence from Firm-Level Surveys", *Journal of Development Studies*, Vol. 44, No. 5, Routledge, London, pp. 701-27.

Amiti, Mary and Amit K. Khandelwal (2009), "Import Competition and Quality Upgrading", *NBER Working Paper*, No. 15503, November 2009.

Amiti, Mary and Jozef Konings (2007), "Trade Liberalization, Intermediate Inputs, and Productivity: Evidence from Indonesia", *American Economic Review*, Vol. 97, No. 5, American Economic Association, Pittsburgh.

Anand, Bharat N. and Tarun Khanna (2000), "The Structure of Licensing Contracts", *Journal of Industrial Economics*, Vol. 48, No. 1, Wiley-Blackwell, Hoboken, pp. 103-35.

Añón Higón, Dolores and Paul Stoneman (2011), "Trade in Final Goods and the Impact of Innovation", *Economics Letters* Vol. 110, Issue 3, Elsevier, Amsterdam, pp. 197-99.

Antràs, Pol, Mihir A. Desai and C. Fritz Foley (2009), "Multinational Firms, FDI Flows and Imperfect Capital Markets", *Quarterly Journal of Economics*, August 2009, MIT Press, Cambridge.

Ariu, Andrea and Giordano Mion (2010), “Trade in Services: IT and Task Content”, *Working Paper Research,* No. 200, National Bank of Belgium, Brussels October 2010.

Arkolakis, Costas, Arnaud Costinot and Andrés Rodriguez-Clare (2009), “New Trade Models, Same Old Gains?”, *NBER Working Paper*, No. 15628, December 2009.

Arora, Ashish, Andrea Fosfuri (2003), “Licensing the market for technology”, *Journal of Economic Behavior & Organization,* Vol. 52, Elsevier, Amsterdam, pp. 277–295.

Arora, Ashish and Alfonso Gambardella (2010a), “Ideas for Rent: An Overview of Markets for Technology”, *Industrial and Corporate Change,* Vol. 19, No. 3, Oxford University Press, Oxford, pp. 775-803.

Arora, Ashish and Alfonso Gambardella (2010b), “Implications for Energy Innovation from the Chemicals Industry”, *NBER Working Paper,* No. 15676, January 2010.

Arora, Ashish, Lee G. Granstetter and Matej Drev (2010), “Going Soft: How the Rise of Software Based Innovation Led to the Decline of Japan's IT Industry and the Resurgence of Silicon Valley”, *NBER Working Paper,* No. 16156, July 2010.

Arrow, Kenneth (1962), “Economic Welfare and the Allocation of Resources for Invention”, in *The Rate and Direction of Inventive Activity: Economic and Social Factors,* National Bureau of Economic Research, Cambridge.

Augier, Patricia, Oliver Cadot and Marion Dovis (2010), “Imports and TFP at the Firm Level: The Role of Absorptive Capacity”, *CEPREMAP Working Papers*, No. 1016, March 2010.

Aw, Bee Yan, Mark J. Roberts and Daniel Yi Zu (2011), “R&D investment, Exporting, and Productivity Dynamics”, *American Economic Review*, Vol. 101, No. 4, American Economic Association, Pittsburgh, pp. 1312-44.

Baldwin, Richard, “Unilateral Tariff Liberalisation”, *NBER Working Paper,* No. 16600, December 2010.

Bennato, Anna Rita, Laura Magazzini (2009), “International Cooperation in Pharmaceutical Research”, *Working Paper Series, Department of Economics, University of Verona*, WP No. 62, October 2009.

Bernard, Andrew B., J. Bradford Jensen, Stephen J. Redding and Peter K. Schott (2007), “Firms in International Trade”, *Journal of Economic Perspectives*, Vol. 21, No. 3, Summer 2007, American Economic Association, Pittsburgh, pp. 105-30.

Blalock, Garrik, Paul J. Gertler (2008), “Welfare Gains from Foreign Direct Investment through Technology Transfer to Local Suppliers”, *Journal of International Economics*, No. 74, Elsevier, Amsterdam, pp. 402-21.

Blalock, Garrick and Francisco M. Veloso (2007), “Imports, Productivity Growth, and Supply Chain Learning”, *World Development* Vol. 35, No. 7, Elsevier, Amsterdam, pp. 1134-51.

Bloom, Nicholas and John Van Reenen (2007), “Measuring and Explaining Management Practices across firms and countries”, *Quarterly Journal of Economics*, Vol. 122, Issue 4, November 2007, MIT Press, Cambridge, pp. 1351-1408.

Bloom, Nicholas and John Van Reenen (2010), "Why Do Management Practices Differ across Firms and Countries?", *Journal of Economic Perspectives*, Vol. 24, No. 1, Winter 2010, American Economic Association, Pittsburgh, pp. 203-24.

Bloom, Nicholas, Mirko Draca and John Van Reenen (2011), "Trade Induced Technical Change? The Impact of Chinese Imports on Innovation, IT and Productivity", *NBER Working Paper*, No. 16717, January 2011.

Branstetter, Lee (2006), "Is Foreign Direct Investment a Channel of Knowledge Spillovers? Evidence from Japan's FDI in the United States", *Journal of International Economics* Vol. 68, Issue 2, Elsevier, Amsterdam, pp. 325-44.

Branstetter, Lee G., Raymond Fisman and C. Fritz Foley (2006), "Do Stronger Intellectual Property Rights Increase International Technology Transfer? Empirical Evidence from U.S. Firm-Level Panel Data", *Quarterly Journal of Economics*, February 2006, MIT Press, Cambridge.

Breinlich, Holger (2008), "Trade Liberalization and Industrial Restructuring through Mergers and Acquisitions", *Journal of International Economics*, Vol. 76, Issue 2, Elsevier, Amsterdam, pp. 254-66.

Bugamelli, Mateo and Fabiano Schivardi (2010), "The Euro and Firm Restructuring", *CEPR Discussion Paper*, No. 7623, January 2010.

Bustos, Paula (2011), "Trade Liberalization, Exports, and Technology Upgrading: Evidence on the Impact of MERCOSUR on Argentinian Firms", *American Economic Review*, Vol 101, American Economic Association, Pittsburgh, pp. 304-40.

Castellani, Davide, Francesco Serti and Chiara Tomasi (2010), "Firms in International Trade: Importers' and Exporters' Heterogeneity in Italian Manufacturing Industry", *The World Economy*, Vol. 33, No. 3, Blackwell Publishing, Hoboken, pp. 424-57.

Chari, Anusha, Wenjie Chen and Kathryn M.E. Dominguez (2009), "Foreign Ownership and Firm Performance: Emerging Market Acquisitions in the United States", *NBER Working Paper*, No. 14786, March 2009.

Chen, Natalie, Jean Imbs and Andrew Scott (2009), "The Dynamics of Trade and Competition", *Journal of International Economics*, Vol. 77, Elsevier, pp. 50-62.

Chor, Davin (2010), "Unpacking Sources of Comparative Advantage: A Quantitative Approach", *Journal of International Economics*, Vol. 82, Elsevier, Amsterdam, pp. 152-67.

Cockburn, Iain M. (2009), "Intellectual Property Rights and Pharmaceuticals: Challenges and Opportunities for Economic Research", in *The Economics of Intellectual Property*, Chapter 5, World Intellectual Property Organization, Geneva.

Coe, David T. and Elhanan Helpman (1995), "International R&D spillovers", *European Economic Review*, Vol. 39, Issue 5, Elsevier, Amsterdam, pp. 859-87.

Coe, David T., Elhanan Helpman and Alexander W. Hoffmaister (2009), "International R&D spillovers and institutions", *European Economic Review*, Vol. 53, Elsevier, Amsterdam, pp. 723-4.

Cohen, Wesley M., Richard R. Nelson and John P. Walsh (2000), "Protecting Their Intellectual Assets: Appropriability Conditions and Why U.S. Manufacturing Firms Patent (or Not)", *NBER Working Paper*, No. 7552, February 2000.

Comin, Diego and Bart Hobijn (2010), "An Exploration of Technology Diffusion", *American Economic Review,* Vol. 100, Issue 5, American Economic Association, Pittsburgh, pp. 2031-59.

Comin Diego A. and Marti Mestieri (2010), "An Intensive Exploration of Technology Diffusion", *NBER Working Paper,* No. 16379, September 2010.

Conway, Paul, *et al.* (2006), "Regulation, Competition and Productivity Convergence", *OECD Economics Department Working Papers,* No. 509, OECD, Paris.

Costinot, Arnaud, Dave Donaldson and Ivana Komunjer (2010), "What Goods Do Countries Trade? A Quantitative Exploration of Ricardo's Ideas", *NBER Working Paper,* No. 16262, August 2010.

Crespi, Gustavo, *et al.* (2008a), "Productivity Growth, Knowledge Flows, and Spillovers", *NBER Working Paper,* No. 13959, April 2008.

Crespi, Gustavo, Chiara Criscuolo and Jonathan Haskel (2008b), "Productivity, Exporting and the Learning-by-Exporting Hypothesis: Direct Evidence from UK Firms", *Canadian Journal of Economics*, Vol. 41, No. 2, Canadian Economics Association, Montreal.

Criscuolo, Chiara, Jonathan E. Haskel and Mathew J. Slaughter (2010), "Global Engagement and the Innovation Activities of Firms", *International Journal of Industrial Organization*, Vol. 28, Elsevier, Amsterdam, pp. 191-202.

Currie, Graeme and Maire Kerrin (2004), "The Limits of a Technological Fix to Knowledge Management: Epistemological, Political and Cultural Issues in the Case of Intranet Implementation", *Management Learning*, Vol. 35, SAGE , Issue 1, pp. 9-29.

Dornbusch, Rudiger, Stanley Fischer and Paul A. Samuelson (1977), "Comparative Advantage, Trade, and Payments in a Ricardian Model with a Continuum of Goods", *American Economic Review*, Vol. 67, No. 5, The American Economic Association, Pittsburgh, pp. 823-39.

Dudley, Leonard and Johannes Moenius (2007), "The Great Realignment: How Factor-Biased Innovation Reshaped Comparative Advantage in the U.S. and Japan, 1970-1992", *Japan and the World Economy,* Vol. 19, Elsevier, Amsterdam, pp. 112-32.

Dulleck, Uwe and Neil Foster (2008), "Imported Equipment, Human Capital and Economic Growth in Developing Countries", *Economic Analysis & Policy*, Vol. 38, No.2, Queensland University of Technology (QUT), School of Economics and Finance, Queensland.

Easterly, William (2002), *The Elusive Quest for Growth: Economists' Adventures and Misadventures in the Tropics*, The MIT Press, Cambridge, Chapter 8.

Eaton, Jonathan and Samuel Kortum (2010), "Trade in Capital Goods", *European Economic Review,* Vol. 45, Elsevier, Amsterdam, pp. 1105-1235.

Eaton, Jonathan, Samuel Kortum, Brent Neiman and John Romalis (2011), "Trade and the Global Recession", *NBER Working Papers,* No. 16666, January 2011.

Ernst & Young (2010), Progressions: Pharma 3.0.

Eslava, Marcela, *et al*. (2009), “Trade Reforms and Market Selection: Evidence from Manufacturing Plants in Colombia”, *NBER Working Paper*, No. 14935, April 2009.

Feenstra, Robert C. (1998), “Integration of Trade and Disintegration of Production in the Global Economy”, *Journal of Economic Perspectives*, Vol 12, No. 4, Fall 1998, American Economic Association, Pittsburgh, pp. 31-50.

Feenstra, Robert C., *et al.* (2009), “Effects of Terms of Trade Gains and Tariff Changes on the Measurement of U.S. Productivity Growth”, *NBER Working Paper*, No. 15592, December 2009.

Fernandes, Ana M. (2007), “Trade Policy, Trade Volumes and Plant-Level Productivity in Colombian Manufacturing Industries”, *Journal of International Economics*, Vol. 71, Elsevier, Amsterdam, pp. 52-71.

Fernandes, Ana Margarida and Caroline Paunov (2010), “Does Trade Stimulate Innovation?: Evidence from Firm-Product Data”, *OECD Development Centre Working Paper*, No. 286, OECD, Paris.

Fliess, Barbara, *et al.* (2010), “The Use of International Standards in Technical Regulation”, *OECD Trade Policy Working Papers* No.102, OECD, Paris.

Freeze, Karen J. (2007), “Unlikely Partners and the Management of Innovation in Communist Europe: A Case Study from the Czechoslovak Textile Machine Industry”, *Business and Economic History On-Line*, Vol. 5, Business History Conference, Wilmington.

Goldberg, Pinelopi K., *et al.* (2010), “Imported Intermediate Inputs and Domestic Product Growth: Evidence from India”, *Quarterly Journal of Economics*, November 2010, Oxford University Press, Oxford.

Gonçalves, Eduardo, Mauro Borges Lemos and Joãn Alberto de Negri, “Drivers of Technological Innovation in Argentina and Brazil”, in J. De Negri and L. Turchi (eds.), *Technological Innovation in Brazilian Argentine Firms*, IPEA, Brasilia, pp. 177-202.

Gorodnichenko, Yuriy, Jan Svejnar and Katherine Terrell (2010), “Globalization and Innovation in Emerging Markets”, *American Economic Journal: Macroeconomics*, Vol. 2, No. 2, American Economic Association, Pittsburgh, pp. 194-226.

Greenaway, David, Joakim Gullstrand and Richard Kneller (2008), “Surviving Globalisation”, *Journal of International Economics*, Vol. 74, No. 2, Elsevier, Amsterdam, pp. 264-77.

Griffith, Rachel, Rupert Harrison and John van Reenen (2006), “How Special is the Special Relationship? Using the Impact of US R&D Spillovers on UK Firms as a Test of Technology Sourcing”, *American Economic Review*, Vol. 96, No. 5, American Economic Association, Pittsbugh.

Grossman, Gene M. and Elhanan Helpman (1991), *Innovation and Growth in the Global Economy*, MIT Press, Cambridge, Chapters 6 and 9.

Grossman, Gene M. and Elhanan Helpman (1995), “Technology and Trade”, in Gene Grossman and Kenneth Rogoff (eds.), *Handbook of International Economics, Vol. 3,* Elsevier, Amsterdam, pp. 1279-1337.

Guadalupe, Maria, Olga Kuzmina and Catherine Thomas (2010), "Innovation and Foreign Ownership", *NBER Working Paper*, No. 17673.

Halpern, László, Miklós Koren, and Adam Szeidl (2005), "Imports and Productivity", *CEPR Working Paper*, No. 5139.

Helpman, Elhanan (2006), "Trade, FDI, and the Organization of Firms", *Journal of Economic Literature*, Vol. 44, No. 3, American Economic Association, Pittsburgh, pp. 589-630.

Helpman, Elhanan and Paul R. Krugman (1985), *Market Structure and Foreign Trade: Increasing Returns, Imperfect Competition and the International Economy*, MIT Press, Campridge.

Hovhannisyan, Nune and Wolfgang Keller (2011), "International Business Travel: An Engine of Innovation?", *NBER Working Paper*, No. 17100, May 2011.

International Federation of Pharmaceutical Manufactures & Associations (IFPMA) (2011), "Technology Transfer: A Collaborative Approach to Improve Global Health, The Research-Based Pharmaceutical Industry Experience", IFPMA, Geneva, www.ifpma.org/fileadmin/content/Global%20Health/Access/Tech%20Transfer/IFPMA_Publication_Technology_Transfer_Booklet_2011.pdf.

Ito, Banri, *et al.* (2010), "How Do Chinese Industries Benefit from FDI Spillovers?", *RIETI Discussions Paper Series* 10-E-026, May 2010.

Ivus, Olena (2010), "Do Stronger Patent Rights Raise High-Tech Exports to the Developing World?", *Journal of International Economics*, Vol. 81, Issue 1, Elsevier, Amsterdam, pp. 38–47.

Javorcik, Beata Smarzynska (2004), "Does Foreign Direct Investment Increase the Productivity of Domestic Firms? In Search of Spillovers Through Backward Linkages", *American Economic Review*, Vol. 94, No. 3, American Economic Association, Pittsburgh.

Jho, Whasun (2007), "Global Political Economy of Technology Standardization: A Case of the Korean Mobile Telecommunications Market", *Telecommunications Policy*, Vol. 31, Issue 2, Elsevier, Amsterdam, pp. 124-38.

Kasahara, Hiroyuki and Joel Rodrigue (2008), "Does the Use of Imported Intermediates Increase Productivity? Plant-Level Evidence", *Journal of Development Economics*, Vol. 86, Issue 1, Elsevier, Amsterdam, pp. 106-18.

Keller, Wolfgang (2004), "International Technology Diffusion", *Journal of Economic Literature* Vol. 32, No. 3, American Economic Association, Pittsburgh, pp.752-82.

Keller, Wolfgang (2009), "International Trade, Foreign Direct Investment, and Technology Spillovers", *NBER Working Paper*, No. 15442, October 2009.

Keller, Wolfgang and Stephen R. Yeaple (2009), "Multinational Enterprises, International Trade, and Productivity Growth: Firm-Level Evidence from the United States", *Review of Economics and Statistics*, Vol. 91, Issue4, MIT Press, Cambridge, pp. 821-31.

Kenney, Martin (1998), "Institutions and Knowledge: The Dilemmas of Success in the Korean Electronics Industry", *Asia Pacific Business Review*, Vol. 5, No. 1, Frank Cass, London, pp. 1-28.

Kiriyama, Nobuo (2010), "Trade and Innovation: Report on the Chemicals Sector", *OECD Trade Policy Working Papers,* No. 103, OECD, Paris.

Kiriyama, Nobuo (2011), "Trade and Innovation: Pharmaceuticals", *OECD Trade Policy Working Papers,* No. 113, OECD, Paris.

Kiriyama, Nobuo (2011), "Trade in Information and Communications Technology and its Contribution to Trade and Innovation", *OECD Trade Policy Working Papers,* No. 115, OECD, Paris.

Klimenko, Mikhail M. (2009), "Policies and International Trade agreements on Technical Compatibility for Industries with Network Externalities", *Journal of International Economics*, Vol. 77, Issue 2, Elsevier, Amsterdam, pp. 151-66.

Kosteas, Vasilio D. (2008), "Trade Protection and Capital Imports in the Mexican Manufacturing Sector", *World Development* ,Vol. 36, No. 12, Elsevier, Amsterdam,pp. 2822-37.

KPMG International (2009), "The Drug Discovery industry in China and India", *Issues Monitor: Pharmaceuticals*, Vol. 4, KPMG International, New York, pp. 11-24.

Krishna, Pravin, Asha Sundaram and Devashish Mitra (2010), "Trade, Poverty and the Lagging Regions of South Asia", *NBER Working Paper*, No. 16322, September 2010.

Krugman, Paul R. (1995), "Increasing Returns, Imperfect Competition and the Positive Theory of International Trade", in Gene Grossman and Kenneth Rogoff (eds.), *Handbook of International Economics, Vol. 3,* Elsevier, Amsterdam, pp. 1243-77.

Krugman, Paul R. (2009), "The Increasing Returns Revolution in Trade and Geography", *American Economic Review 2009,* Vol. 99, No. 3, American Economic Association, Pittsburgh, pp. 561-71.

Leamer, Edward E. and James Levinsohn (1995), "International Trade Theory: The Evidence", in G. Grossman and K. Rogoff (eds.), *Handbook of International Economics, Vol. 3,* Elsevier, Amsterdam, pp. 1339-94.

Lileeva, Alla and Daniel Trefler (2010), "Improved Access to Foreign Markets Raises Plant-Level Productivity … For Some Plants", *Quarterly Journal of Economics*, August 2010, MIT Press, Cambridge.

Liu, Xiaohui and Trevor Buck, "Innovation Performance and Channels for International Technology Spillovers: Evidence from Chinese High-Tech Industries", *Research Policy,* Vol. 36, Elsevier, Amsterdam, pp. 355-66.

De Loeker, Jan (2007), "Do Exporters Generate Higher Productivity? Evidence from Slovenia", *Journal of International Economics,* Vol. 73, Issue 1, Elsevier, Amsterdam, pp. 69-98.

Maddux, William W. and Adam D. Galinski (2009), "Cultural Borders and Mental Barriers: The Relationship Between Living Abroad and Creativity", *Journal of Personality and Social Psychology,* Vol. 96, No. 5, American Psychology Association, Washington, DC, pp. 1047-61.

MacGarvie, Megan (2006), "Do Firms Learn from International Trade?", *The Review of Economics and Statistics*, Vol. 88, Issue 1, MIT Press, Cambridge, pp. 46-60.

Mahdi, Surya, Paul Nightingale and Frans Berkhout (2002), *A Review of the Impact of Regulation on the Chemical Industry: Final Report to the Royal Commission on*

Environmental Pollution, SPRU-Science and Technology Policy Research, University of Sussex.

Mancusi, Maria Luisa (2008), "International spillovers and absorptive capacity: A cross-country cross-sector analysis based on patents and citations", *Journal of International Economics*, Vol. 76, No. 2, Elsevier, Amsterdam, pp. 155–165.

Mann, Catherine L. (2009), "Trade in ICT and its Contribution to Trade and Innovation: The Channels of Contribution", internal working document, OECD Trade and Agriculture Directorate, Paris.

McKinsey & Company (2011a), "R&D Strategies in Emerging Economies McKinsey Global Survey Results", *McKinsey Quarterly,* April 2011.

McKinsey & Company (2011b), "When Big Acquisitions Pay Off", *McKinsey on Finance*, No. 39.

McKinsey & Company (2011c), "Innovation in Chemicals: An Interview with Dow Corning's CEO and CTO", *McKinsey Quarterly*, May 2011.

McKinsey & Company (2011d), "Preparing Your Organization for Growth", *McKinsey Quarterly*, May 2011.

Melitz, Marc J. and Giancarlo I. P. Ottaviano (2008), "Market Size, Trade, and Productivity", *Review of Economic Studies*, Vol. 75, Oxford University Press, Oxford, pp. 295-316.

Montobbio, Fabio and Valerio Sterzi (2011), "Inventing Together: Exploring the Nature of International Knowledge Spillovers in Latin America", *Journal of Evolutionary Economics*, Vol. 21, No. 1, Springer, New York, pp. 53-89.

Motohashi, Kazuyuki and Yuan Yuan (2009), "Technology Spillovers from Multinationals in Local Firms: Evidence from Automobile and Electronics Firms in China", *RIETI Discussion Paper Series* 09-E-005.

Nishimura, Kiyohiko G., Takanobu Nakajima and Kozo Kiyota (2005), "Innovation Versus Diffusion: Determinants of Productivity Growth Among Japanese Firms", CIRJE-F-350, June 2005, University of Tokyo.

OECD (1998), "Savings to Governments And Industry Resulting From the OECD Environmental Health and Safety Programme", internal working document,OECD Environment Directorate, Environment Ministerial Steering Group, Paris.

OECD (2000a), "Standardisation and regulatory reform: selected cases", OECD Working Papers, TD/TC/WP(99)47/FINAL, Vol. 8, No. 9, OECD, Paris.

OECD (2000b), "An Assessment of the Costs for International Trade in Meeting Regulatory Requirements", OECD Working Papers, TD/TC/WP(99)8/FINAL, OECD, Paris.

OECD (2002), "Non-Tariff Measures in the ICT Sector: A Survey", OECD Working Papers, TD/TC/WP(2001)44/FINAL, OECD, Paris.

OECD (2008a), "Innovation without Borders: The Role of Trade in Innovation", *OECD Journal: General Papers, Special Issue: Innovation without Borders: The Role of Trade in Innovation*, Volume 2008/4, OECD Publishing, Paris.

OECD (2008b), "Insights from Company Case Studies", *Open Innovation in Global Networks*, Chapter 3, OECD Publishing, Paris, pp. 77-111.

OECD (2009), *Innovation in Firms: A Microeconomic Perspective*, OECD Publishing, Paris.

OECD (2010a), "Ministerial Report on the OECD Innovation Strategy: Fostering Innovation to Strengthen Growth and Address Global and Social Challenges – Executive Summary", internal document, OECD, Paris.

OECD (2010b), *The OECD Innovation Strategy: Getting a Head Start on Tomorrow*, OECD Publishing, Paris.

OECD (2010c), "Trade and Economic Effects of Responses to the Economic Crisis – Policy Note", TAD/TC/WP(2010)11/FINAL, OECD, Paris.

OECD (2010d), *Cutting Costs in Chemicals Management: How OECD Helps Governments and Industry*, OECD Publishing, Paris.

OECD/Statistical Office of the European Communities, Luxembourg (2005), *Oslo Manual: Guidelines for Collecting and Interpreting Innovation Data, 3rd Edition*, The Measurement of Scientific and Technological Activities, OECD Publishing, Paris.

Onodera, Osamu (2008), "Trade and Innovation: A Synthesis", *OECD Journal: General Papers, Special Issue: Innovation without Borders: The Role of Trade in Innovation*, Volume 2008/4, OECD, Paris.

Pavcnik, Nina (2002), "Trade Liberalization, Exit, and Productivity Improvements: Evidence from Chilean Plants", *Review of Economic Studies,* No. 69, The Review of Economic Studies Ltd., Hoboken, pp. 245-276.

Park, Walter G. and Douglas C. Lippoldt (2008), "Technology Transfer and the Economic Implications of the Strengthening of Intellectual Property Rights in Developing Countries", *OECD Trade Policy Working Papers,* No. 62, OECD, Paris.

Park, Albert, *et al.* (2010), "Exporting and firm performance: Chinese exporters and the Asian financial crisis", *Review of Economics and Statistics*, Vol. 92, No. 4, MIT Press, Cambridge, pp. 822-42.

Porter, Michael E. (1980), *Competitive Strategy: Techniques for Analyzing Industries and Competitors*, Free Press, New York.

Portugal-Perez, Alberto, José-Daniel Reyes and John S. Wilson (2010), "Beyond the Information Technology Agreement: Harmonisation of Standards and Trade in Electronics", *The World Economy*, Vol. 33, Issue 12, Blackwell Publishing Ltd., Hoboken, pp. 1870-97.

Prichard, Craig (2000),"Know, Learn and Share! The Knowledge Phenomena and the Construction of a Consumptive-Communicative Body" in Craig Prichard, *et al.* (eds.), *Managing Knowledge: Critical Investigations of Work and Learning*, MacMillan Press Ltd., London, pp. 176-98.

Qian, Yi (2007), "Do National Patent Laws Stimulate Domestic Innovation in a Global Patenting Environment? A Cross-Country Analysis of Pharmaceutical Patent Protection, 1978-2002", *Review of Economics and Statistics*, Vol. 89, No. 3, MIT Press, Cambridge.

Qian, Yi (2010), "Are National Patent Laws the Blossoming Rain?" *NBER Working Paper*, No. 16295, August 2010.

Ten Raa, Thijs and Pierre Mohnen (2008), "Competition and Performance: The Different Roles of Capital and Labor", *Journal of Economic Behavior & Organization*, Vol. 65, Elsevier, Amsterdam, pp. 573-84.

Ricardo, David (1817), "On Foreign Trade", in Piero Sraffa (ed.) *The Works and Correspondence of David Ricardo, Vol. 1 Principles of Political Economy and Taxation,* Cambridge University Press, London.

Sandrey, Ron and Nick Vink (2008), "Deregulation, Trade Reform and Innovation in the South African Agriculture Sector", in *OECD Journal: General Papers, Special Issue: Innovation without Borders: The Role of Trade in Innovation*, Volume 2008/4, OECD.

Scherer, Frederic M. (2000), "The Pharmaceutical Industry", in Anthony J. Culyer and Joseph P. Newhouse (eds.), *Handbook of Health Economics, Volume 1*, Elsevier Science B.V., Amsterdam.

Schiff, Maurice and Yanling Wang (2010), "North-South Technology Spillovers: The Relative Impact of Openness and Foreign R&D", *International Economic Journal*, Vol. 24, No. 2, Routledge, London, pp. 197-207.

Schumpeter, Joseph A. (1942), *Capitalism, Socialism and Democracy*, reproduced in Harper Perennial Modern Classics (2008), HarperCollins, New York, Chapter 8.

Shikher, Serge (2011), "Capital, Technology and Specialization in the Neoclassical Model", *Journal of International Economics,* Vol. 83, Elsevier, Amsterdam, pp. 229-42.

Spulber, Daniel F. (2008), "Innovation and International Trade in Technology", *Journal of Economic Theory* Vol. 138, Issue 1, Elsevier, Amsterdam, pp. 1-20.

Spulber, Daniel F. (2010), "The Quality of Innovation and the Extent of the Market", *Journal of International Economics,* Vol. 80, Elsevier, Amsterdam, pp. 260-70.

Staiger, Robert W. and Alan O. Sykes (2009), "International Trade and Domestic Regulation", *NBER Working Paper,* No. 15541, November 2009.

Stone, Susan F. and Ben Shepherd (2011), "Dynamic Gains from Trade: The Role of Intermediate Inputs and Equipment Imports", *OECD Trade Policy Working Papers,* No. 110, OECD, Paris.

Syverson, Chad (2010), "What Determines Productivity?" *NBER Working Paper,* No. 15712, January 2010.

Topalova, Petia and Amit Khandelwal (2011), "Trade Liberalization and Firm Productivity: The Case of India", *The Review of Economics and Statistics*, Vol. 93, No. 3, MIT Press, Cambridge, pp. 995-1009.

Trachtman, Joel P. (2006), "The World Trading System, the International Legal System and Multilevel Choice", *European Law Journal*, Vol. 12, No. 4, Blackwell Publishing Ltd., Hoboken, pp. 469-85.

Trefler, Daniel (2004), "The Long and Short of the Canada-U.S. Free Trade Agreement", *American Economic Review,* Vol. 94, No. 4, American Economic Association, Pittsburgh.

Vogel, Alexander and Joachim Wagner (2009), "Higher Productivity in Importing German Manufacturing Firms: Self-Selection, Learning from Importing, or Both?", *Review of World Economics,* Vol. 145, No. 4, Springer, New York, pp. 641-65.

Verhoogen, Eric A. (2008), "Trade, Quality Upgrading, and Wage Inequality in the Mexican Manufacturing Sector", *Quarterly Journal of Economics*, Vol. 123, Issue 2, MIT Press, Cambridge, pp. 489-530.

Wagner, Joachim (2007), "Exports and Productivity: A Survey of the Evidence from Firm-level Data", *World Economy,* Vol. 30, No. 1, Blackwell Publishing Ltd., Hoboken, pp. 60-82.

Wijayasiri, Janaka and Jagath Dissanayake (2008), "The Ending of the Multi-Fibre Agreement and Innovation in the Sri Lankan Textile and Clothing Industry", in *OECD Journal: General Papers, Special Issue: Innovation without Borders: The Role of Trade in Innovation,* Volume 2008/4, OECD, Paris.

Wakasugi, Ryuhei and Banri Ito (2009), "The Effects of Stronger Intellectual Property Rights on Technology Transfer: Evidence from Japanese Firm-Level Data", *Journal of Technology Transfer*, Vol. 34, No. 2, Springer, New York, pp. 145-158.

Wolff, Edward N. (2011), "Spillovers, Linkages, and Productivity Growth in the US Economy", *NBER Working Paper,* No. 16864, March 2011.

World Bank (2008), "Determinants of Technological Diffusion: Recent Trends and Prospects", *Global Economic Prospects 2008: Technology Diffusion in the Developing World,* The World Bank, Washington, D.C.

World Trade Organization (WTO) (2008a), *World Trade Report 2008: Trade in a Globalizing World*, WTO, Geneva, pp. 27-80.

WTO (2008b), "Fourth revision of draft modalities for non-agricultural market access", TN/MA/W/103/Rev.3, 6 December 2008.

WTO (2010), "Report to the TPRB from the Director-General on Trade-Related Developments", WT/TPR/OV/W/3, 14 June 2010.

WTO (2011), "Report by the Director-General on his consultations on NAMA sectoral negotiations", TN/C/14, 21 April 2011.

Yashiro, Naomitsu and Daisuke Hirano (2010), "Anatomy of Learning-from-Exporting: Role of Foreign Knowledge Acquisition", *RIETI Discussion Paper Series* 01-E-053, October 2010.