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Trade Policy Implications of Global Value Chains

CASE STUDIES

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Abstract

Trade Policy Implications of Global Value Chains: Case studies

Taking global value chains (GVCs) into account has important implications for trade policy. When production is vertically fragmented and trade in intermediate inputs is prevalent, one has to look differently at a certain number of issues. Through case studies, this paper provides new evidence on the incidence on services of tariffs levied on goods (case study 1) and then discusses effective rates of protection in a world of GVCs and what the removal of tariffs on intermediate inputs implies, using the example of Canada (case study 2). To illustrate how trade agreements could be made more relevant for GVCs, the paper further looks at sectoral approaches in trade negotiations through the example of the Information Technology Agreement (case study 3) and finally compares the network of regional trade agreements in force with global production networks (case study 4).

Keywords: global value chains, fragmentation of production, vertical specialization, cumulative tariffs, trade in intermediate inputs, effective rates of protection, network trade, regional trade agreements.

JEL classification: F13, F14, F15, F23

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Table of contents

Tables

Figures

Executive summary

This paper provides additional detail on the four case studies included in the chapter "Implications of Global Value Chains for Trade Policy" published in *Interconnected Economies – Benefiting from Global Value Chains*, (OECD, 2013).

The first case study examines the interdependencies between goods and services trade and assesses the extent to which tariffs on goods affect services suppliers. It emphasises that as an increasing share of the value of merchandise exports is made of services value-added – such as transport, distribution, finance, communication and business services – it makes better sense for trade policy measures on goods and services to be dealt with together.

The burden of tariffs for upstream and downstream services providers is estimated using newly developed methodological tools on the calculation of cumulative tariffs in global value chains (GVCs). The analysis reveals that over 30% of total collected tariffs were paid on services value-added in 2009. Although there are differences across sectors, services suppliers appear to incur a substantive share of tariff costs in all manufacturing sectors and in countries at various levels of development. A GVC approach can thus change the perspective of who actually bears the cost of protectionist policies and highlights the benefits of a trade policy agenda that jointly addresses goods and services liberalisation.

In addition, tariffs levied on goods can impact on services sectors which rely on imported intermediate goods. The indirect tariff costs incurred in previous stages of services GVCs and embodied in the price of final services exports are, however, estimated to be small in most economies. They have been significantly reduced since 2000 as a result of unilateral, regional and multilateral liberalisation of manufacturing imports.

The second case study addresses the role that openness to imports plays in improving export competitiveness. To this end, it analyses the effects of the unilateral removal of tariffs on manufacturing inputs carried out by Canada in 2010. The tariff relief on intermediate inputs was expected to improve the access of Canadian manufacturers to world-class technology and bolster their productivity.

It is estimated that the policy will reduce effective protection significantly in "coke and refined petroleum" and to a lesser extent in other manufacturing sectors. Imports of inputs covered by the tariff relief are expected to rise, as Canada's intermediate goods imports are found to be strongly sensitive to tariff reductions while imports of consumption and capital goods do not appear to respond significantly to tariff rates. In turn, enhanced access to foreign intermediate inputs reduces costs and encourages innovation. Preliminary results indicate that the productivity gains from the unilateral tariff relief are potentially quite large. For instance, the expected gains in multifactor productivity are estimated to be over 3% in textiles, 1.6% in chemicals and 0.6% in transportation equipment, relative to 2008.

The third case study deals with the WTO Information Technology Agreement (ITA) and highlights that GVCs are more developed in IT industries and that parties to the agreement have higher participation rates in such GVCs, especially developing countries. An analysis of the "tariff value chain" – relying on the concept of cumulative tariffs – points out that the

agreement was successful in reducing average tariffs levied on first-tier suppliers of inputs but that there are still non-trivial indirect tariffs creating costs for IT exporters upstream in the value chain. These tariffs are in industries not covered by the ITA.

Moreover, there are differences across IT industries. For "office, accounting and computing machinery", tariffs on direct inputs and exports of final products have almost disappeared but there are still significant cumulative tariffs because duties on inputs upstream (beyond the first tier suppliers) are rather high in this industry. In the case of "electrical machinery", exports of final goods still face significant tariffs and tariffs on inputs are lower. As for "TV and communication equipment", both exports of final goods and indirect tariffs on inputs are at a higher level, with an average cumulative tariff of 5% at the end of the value chain.

While sectoral approaches can be interesting, an international supply chain agreement should ideally have a broader coverage to include all industries involved in a given value chain and go beyond tariffs, to cover services, non-tariff barriers such as technical regulations, standards, customs and administrative procedures, as well as some investment and competition issues.

Lastly, the fourth case study examines the match between global value chains and the network of regional trade agreements (RTAs). Using a network trade index indicating the importance of each partner country as a supplier of inputs in the value chain and a RTA index measuring the existence and depth of regional trade agreements, the "symmetry" between production and RTA networks in 2009 is assessed.

In North America and in Europe, there is a good match between regional vertical trade and deep integration agreements, but the correlation is not at its highest level because there is not yet a transatlantic trade agreement and key partners in Asia are not covered by the RTAs signed by the United States and the European Union. In Asia, high correlation coefficients are reported for ASEAN economies, but the large economies of the region are not yet integrated in deep provisions agreements among themselves.

One could discuss whether countries should try to achieve a perfect symmetry between their production networks and their network of RTAs. But there are certainly economic arguments in favour of deep provisions agreements with the main vertical trade partners who provide inputs for exports. Taking into account the cumulative impact of barriers along the value chain (as emphasised in the three previous case studies), this would suggest the logic of negotiation is for broad agreements covering enough partners and industries to avoid distortions in the chain of inputs. There is then a trade-off between how far deep integration can go with respect to issues relevant for GVCs and the number of partners involved in the negotiation.

Introduction

Global value chains (GVCs) have become a dominant feature of the world economy, involving countries at all levels of development and reflecting the increasing fragmentation and sophistication of production for both goods and services. With the launch of the Trade in Value-Added database in January 2013 and the release of the publication *Interconnected Economies: Benefiting from Global Value Chains* at the OECD Ministerial Council Meeting in May 2013, important progress has been made towards a better understanding of how international production networks impact trade, investment and growth.

This work has important consequences for trade policy and the first policy implications have been explored in the chapter "Implications of global value chains for trade policy" of the recent OECD publication *Interconnected Economies: Benefiting from Global Value Chains*, (OECD, 2013). The chapter included references to four illustrative case studies. This paper provides more analysis and details on these case studies and further examines some of the policy implications previously discussed.

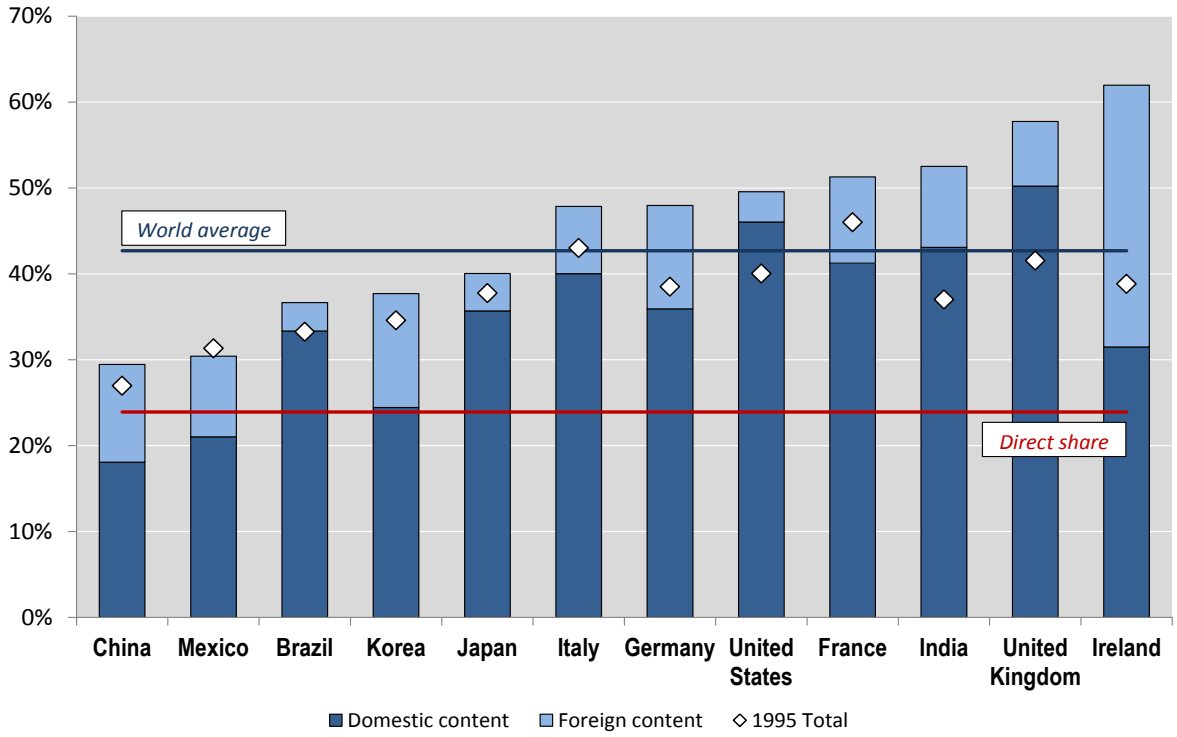
In particular, the paper includes:

- A presentation of the cumulative impact of tariffs in global value chains and what we can learn from a GVC view on tariffs. New methodological tools are introduced that are used in the four case studies of the paper;
- New evidence on the incidence on services of tariffs levied on goods (case study 1), illustrating that trade in goods and trade in services are increasingly intertwined and are better addressed together from a policy perspective;
- A discussion of effective rates of protection in a world of global value chains and what the removal of tariffs on intermediate inputs imply (using the example of Canada, case study 2);
- A discussion of plurilateral and sectoral approaches in trade negotiations through the example of the Information Technology Agreement (case study 3) and further reflections on how trade agreements could be made relevant for global value chains;
- A comparison between the network of regional trade agreements and global production networks (case study 4), with some implications for the negotiation of trade agreements.

Case study 1: Quantifying indirect tariffs on services

An implication of offshoring and the fragmentation of production is that goods and services sectors are increasingly intertwined. An increasing share of the value of manufacturing goods is made of services value-added: domestic and imported services inputs used along the production process account for a third of the total value of exports in transport equipment, textile, chemicals or food products (OECD, 2013). The rise of outsourcing has increased this share, as activities previously supplied in-house are now outsourced and become services inputs. The quality of supporting services sectors thus contributes significantly to competitiveness in manufacturing (Nordås and Kim, 2013). As a result of this "servicification" of manufacturing (National Board of Trade, 2012b), services play a larger role in world trade than what gross trade statistics suggest. The direct share of services sectors in world gross exports is 24%. But in value-added terms, over 42% of total gross exports originate, directly or indirectly, in services sectors (Figure 1).

Figure 1. Services content of gross exports, 2009



Source: OECD-WTO Trade in Value Added database (May 2013 release)

At the same time, services suppliers rely on domestic and imported manufacturing inputs. Import barriers restricting access to high-quality intermediate goods at a competitive cost hurt not only downstream manufacturing sectors, but also services firms that are direct or indirect users of these intermediate inputs. The interdependence between goods and services therefore questions the traditional "silo" approach to trade liberalisation which addresses each policy area in isolation. Manufacturing exporters benefit from more open and more competitive services markets, and services exporters have a stake in the liberalisation of trade in goods as they indirectly bear part of the cost of tariffs and non-tariff measures.

More generally, in internationally fragmented production processes, tariffs and other trade costs are cumulative along the value chain. As products cross borders multiple times, tariffs imposed at a given point in a global value chain impact on upstream and downstream producers and may affect the competitiveness of the entire value chain. The magnification of tariffs in vertical specialisation trade was derived theoretically by Yi (2003) and was first quantified empirically by Rouzet and Miroudot (2013) using the OECD Inter-Country Input-Output (ICIO) model.

This case study analyses the cumulative nature of tariffs with a specific focus on services, using data on inter-country, inter-industry linkages from the OECD ICIO and Trade in Value-Added (TiVA) data. The first part looks at the role of services inputs in manufacturing exports and estimates the share of manufacturing tariffs that is supported by intermediate services suppliers. The second part deals with the direct and indirect use of imported intermediate goods in the production of services and quantifies the value of tariffs embodied in services exports, by trade partners and services sectors. This study shows how GVC analysis

can change the perception of who actually bears the cost of protectionist policies, challenging the conventional view that tariffs are not an issue for services suppliers.

Do upstream services suppliers bear the cost of tariffs on goods?

When intermediate or final goods cross borders, import duties are paid on the basis of the gross value of the good. As a consequence, services embodied in goods bear part of these duties. The value of tariffs supported by services value-added (internationally traded or not) has never been calculated.

The estimation of tariffs paid on services value-added draws on the concept of cumulative tariffs along the value chain. The calculation of cumulative tariffs takes the perspective of the whole value chain to add up the tariff costs that are paid on a good or a service at all stages of its production process. For instance, suppose there is a three-stage GVC in which a final goods or services producer (stage 3) uses inputs from services firms, domestic goods and imported goods (stage 2). Its costs are raised by tariffs on those imported intermediate goods. In addition stage-2 goods and services inputs are themselves made with, *inter alia*, imported intermediate goods (stage 1); stage-1 imported goods are used as intermediate inputs into stage-2 production and pay tariffs at that stage. The longer and more complex the value chain, the more trade costs are amplified as tariffs are levied on the full value of a good at each stage (including previously incurred trade costs) rather than on the value added in the last production stage. As value chains are increasingly global, multiple border crossings thus amplify the impact of trade costs: tariffs are cumulative and downstream industries are affected by the whole structure of trade costs along their production process. The OECD ICIO model allows us to trace the origin of inputs used by each industry in each country and calculate the cumulative value of tariffs along GVCs.[1]

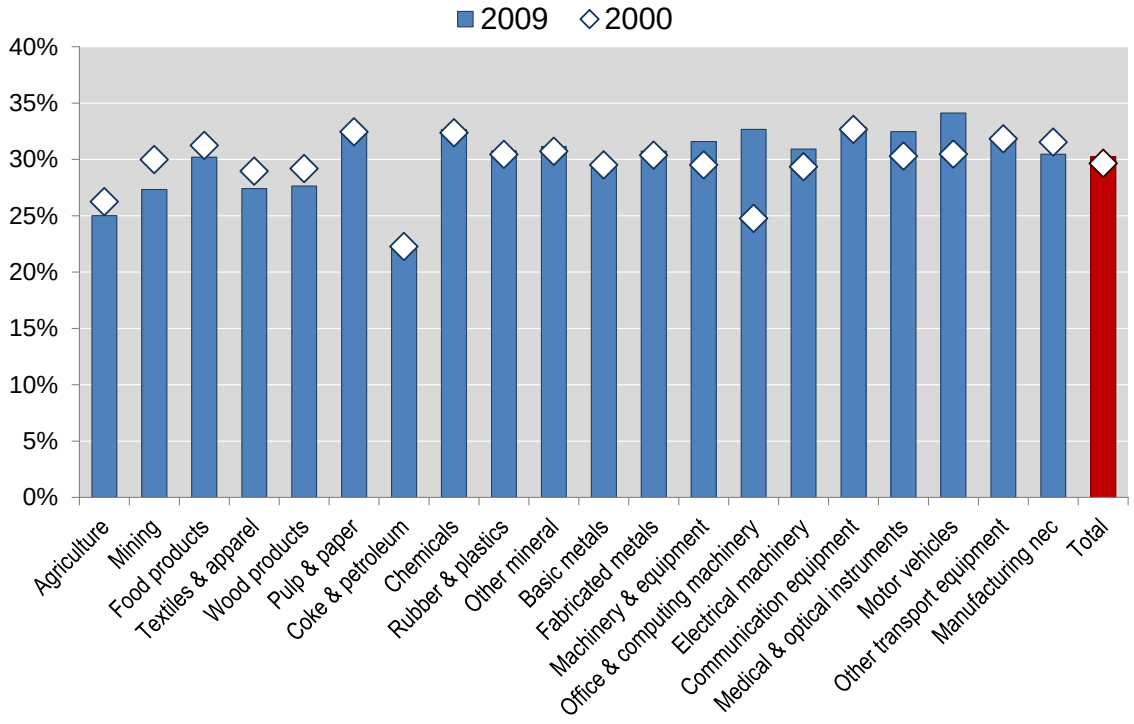
Similarly, we can estimate the share of world cumulative tariffs on imports from each goods sector that is in fact paid on services value-added. To this end, we first assess the total direct and indirect contribution of services to value-added in primary and manufacturing industries as well as services sectors themselves. Then, for each sector, we add up the tariffs that were levied on services value-added at every stage of its value chain. The total share of tariffs supported by services suppliers along an industry's global value chain is the ratio of the cumulative tariffs on services value-added thus obtained and total cumulative tariffs in the industry.

The results are presented by industry of final imports, aggregated over direct source countries and destination countries using trade shares from the TiVA database. It should be noted that the share of total tariffs supported by services value-added is influenced not only by the total services value-added embodied in a given industry, but also by the structure of the value chain. In particular, it depends on whether intermediate services tend to be used more intensively upstream or downstream in manufacturing production processes. Services that are added to the production of intermediate inputs at the beginning of value chains (e.g. transport of raw materials) are subject to tariffs multiple times as those intermediate goods cross borders several times before the final good is eventually assembled and shipped to consumers, while services that are added in the final stages (e.g. retail distribution) only incur tariffs once or not at all. In fact, we find that the share of tariffs paid on services value-added is lower than the share of services in total value-added in most industries, suggesting that intermediate services are used relatively more in later stages of global value chains.

1. The details and formula for these calculations are described in Annex B.

The shares of total import duties that are paid on services value-added, by category of imports, are shown on Figure 2. Overall, 30% of total collected tariffs are estimated to have been paid on value-added that originated in services sectors in 2009. These shares are even higher in most manufacturing import sectors, but are lower for imports from the mining and quarrying industry and from the coke, refined petroleum and nuclear fuel sectors (around 20%) which are less intensive in services inputs. The total share remained stable between 2000 and 2009, although there were some shifts at the industry level; in particular regarding office equipment imports, for which the burden of tariffs increasingly shifted towards upstream services suppliers over time as the services content of the industry was rising.

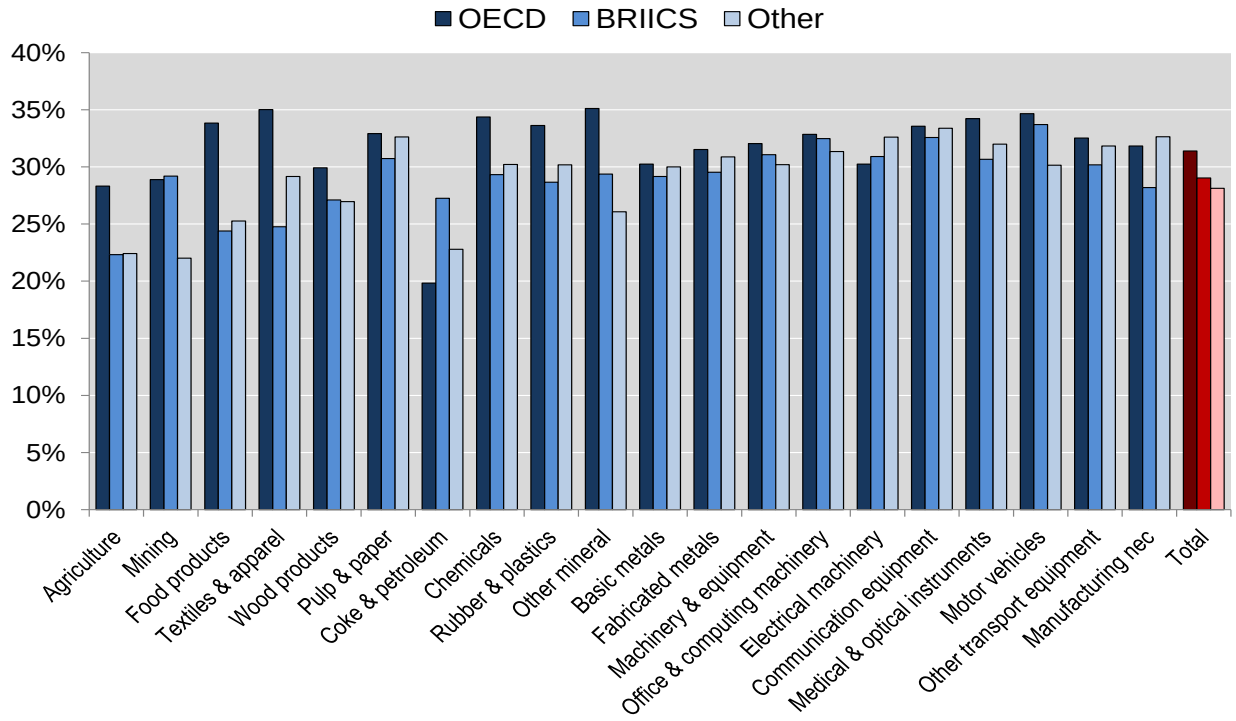
Figure 2. Share of tariffs paid on services value-added, by sector of imports



Source: Author's calculations using the OECD ICIO model and TRAINS.

Figure 3 presents the same indicator but distinguishes according to whether the direct source country is an OECD member, a Key Partner or Accession country (Russia, Brazil, China, India, Indonesia and South Africa [BRIICS]) or another economy. The general pattern is that tariffs on imports from non-OECD economies (including import duties incurred further upstream in the GVC) affect services value-added less than tariffs on imports from OECD countries, which tend to rely more intensively on inputs from services sectors. The same holds between large emerging economies and other non-OECD countries. However, with the exception of a few sectors such as food products and textiles, the differences are small in manufacturing industries. This highlights the fact that services are key intermediate inputs into manufacturing, and significant components of the value-added that is hit by import duties, at all stages of development.

Figure 3. Share of tariffs paid on services value-added, by sector and source of imports



Source: Author's calculations based the OECD ICIO model and TRAINS.

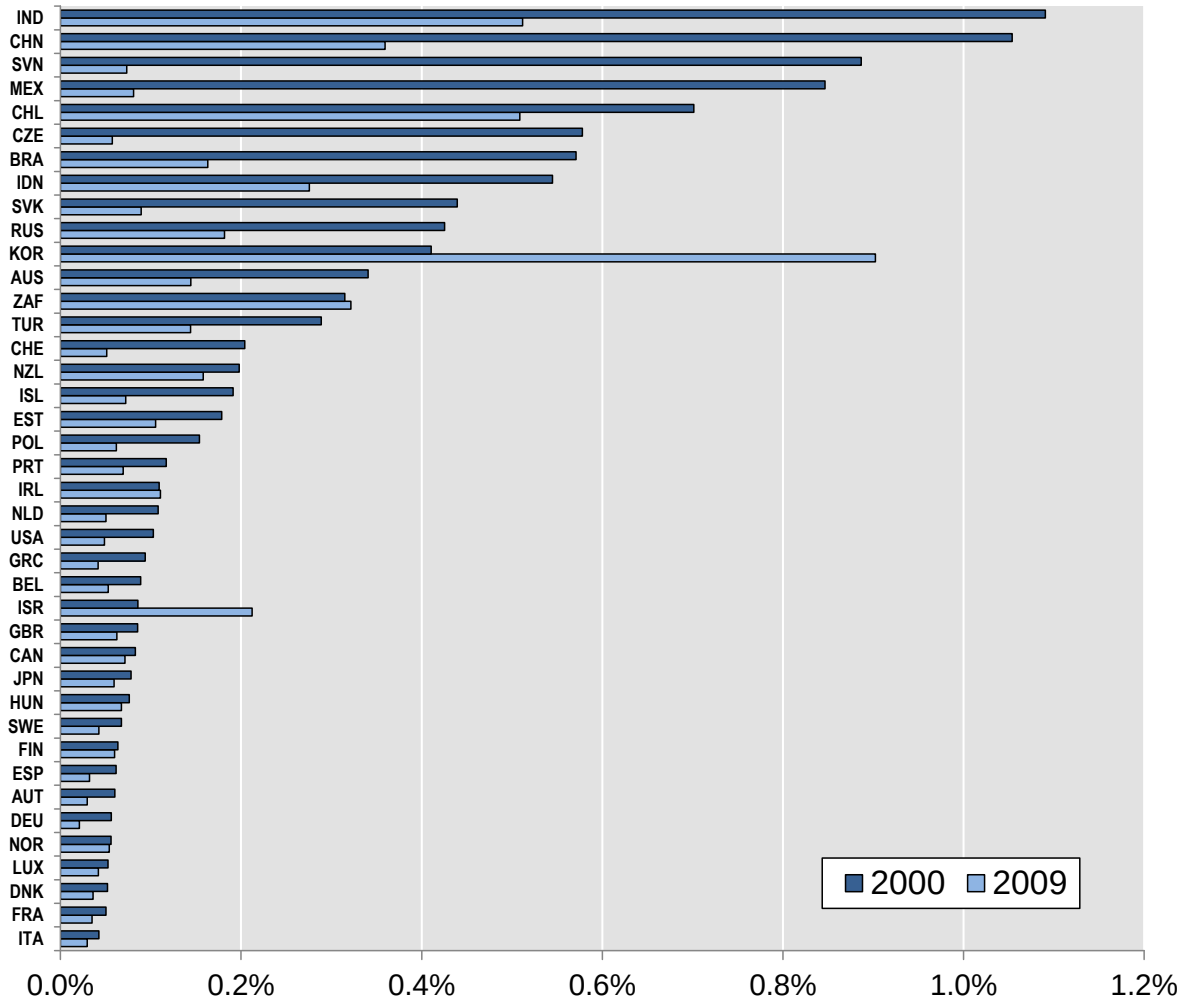
Do tariffs on intermediate goods affect services trade?

The first section considered the burden imposed on services suppliers by tariffs paid on goods at downstream stages of a global value chain. There is a second way in which tariffs on goods are likely to adversely affect services providers, whether they export or not. Not only are there services inputs into agriculture and manufacturing; as mentioned above, there are also intermediate goods used as inputs into services GVCs. This section therefore explores the cost for services suppliers of import duties paid on the intermediate goods used in services GVCs.

Although services flows are not subject to direct import duties, they are affected by trade costs incurred further up the value chain. Tariffs on intermediate goods used by services suppliers can raise the cost and reduce the competitiveness of services exports. This case study provides a first estimate of this effect by calculating the indirect tariff costs embodied in services trade, following the methodology presented in the previous section. As there are no direct tariffs on services imports, cumulative tariffs on services are entirely composed of indirect tariffs.

The estimates of indirect tariffs supported by services trade for 2000 and 2009 are shown on Figure 4. Indirect tariffs are calculated for each service exporting country as a weighted average across services sectors. Although their overall magnitude appears small, they are not negligible in some countries compared to the tariffs on manufacturing products applied by high and middle-income countries.

Figure 4. Indirect tariffs on services exports, all destinations, 2000 and 2009[2]



Source: Author's calculations using the OECD ICIO model and TRAINS. Countries on the vertical axis are the services exporters.

The cost of upstream tariffs for services exporters has been largely reduced in almost all countries between 2000 and 2009, except in Korea where, in particular, the effect of agricultural protection on the tourism industry appears to have risen.[3] The impact of indirect tariffs on the cost of services imports from the People's Republic of China, India and Brazil has been cut in 2009 to a fraction of what it was in 2000, in part as a result of these countries lowering their own trade barriers. An even larger reduction is seen for Central European

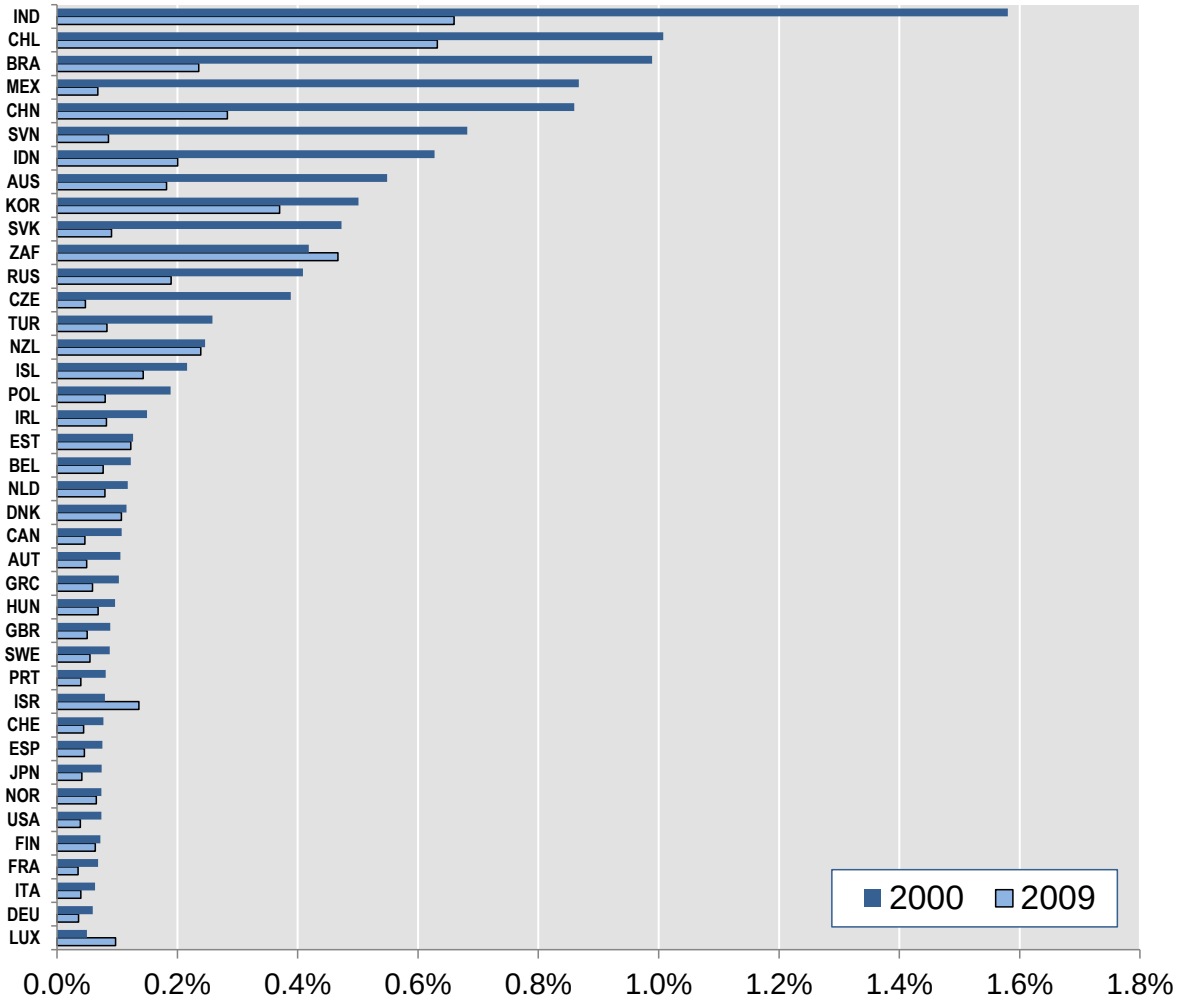
2. The statistical data for Israel are supplied by and under the responsibility of the relevant Israeli authorities. The use of such data by the OECD is without prejudice to the status of the Golan Heights, East Jerusalem and Israeli settlements in the West Bank under the terms of international law.

3. Note that the apparent increase on Figure 4 is due to the Korean quotas on a number of agricultural imports; the high tariffs on out-of quota imports for these products were not fully taken into account in the TRAINS data for 2000. Hence the 2000 value for Korea on Figure 4 is likely to be underestimated and should be interpreted with caution. The 2009 data include *ad valorem* equivalents of agricultural quotas.

countries such as Slovenia, the Czech Republic and the Slovak Republic. As they source the bulk of their imports of intermediate goods from within the European Union, their accession to the European Union in 2004 and the resulting abolition of tariffs on intermediate imports from other EU members has all but eliminated indirect tariffs on services. Services exports from larger EU countries, which tend to source their intermediate inputs tariff-free either locally or from other EU member countries, embody the lowest tariffs.

Figure 5 presents the corresponding estimates focusing on a specific services sector: transport and storage services. The cost of indirect tariffs for services suppliers tends to be larger in this sector than for the average service export, but a similar pattern emerges. The highest indirect tariffs are borne by services from emerging economies (India, Chile, South Africa, and to a lesser extent China and Brazil), but they have been considerably reduced over the past decade. Transport services suppliers from the European Union are little affected by upstream tariffs, and the effect of accession is visible for more recent members. No country showed a significant increase in indirect tariffs over the period considered.

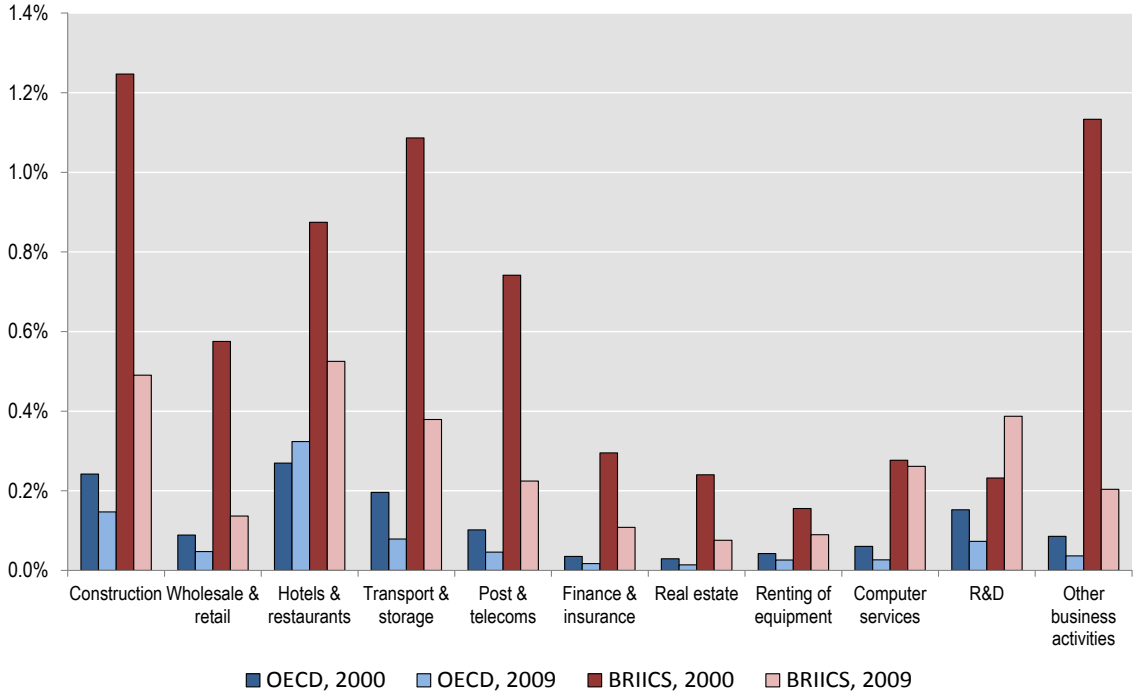
Figure 5. Indirect tariffs on transport and storage services exports, all destinations, 2000 and 2009



Source: Author's calculations using the OECD ICIO model and TRAINS.

To explore further these patterns, Tables C.1 and C.2 (in Annex C) delve into bilateral relationships and present summary matrices of indirect tariffs on services, respectively in 2000 and 2009, for selected countries and regions. The values shown estimate the tariffs embodied in services exported from the source economy (in rows) to the destination economy (in columns), as a percentage of the total value of the service. For instance, tariffs incurred upstream represented on average 1.4% of the value of Indian exports of services to the European Union in 2000. Interestingly, domestic services sales are not exempt from cost increases due to tariffs on imported goods: in 2000, locally supplied services embodied tariffs above 1% in China and India. These indirect tariffs on own sales were then reduced in subsequent years, as well as those on exports to various partners. At the same time, the rise in indirect tariffs on Korean services exports is observed towards most destinations, with the cost for services exports to Canada exceeding 2%. The trend only differs for Korean services exported to the United States, on which the indirect tariff remained low and even declined slightly due to a different composition of the services exports bundle.

Figure 6. Indirect tariffs on services imports, by sector, 2000 and 2009



Source: Author's calculations using the OECD ICIO model and TRAINS.

Finally, not all services sectors are equally affected by tariffs incurred upstream in the production process. Figure 6 shows the cost of indirect tariffs on services imports by service sector, distinguishing between OECD (34 current members) and BRIICS importers. The values are larger for services imports into large emerging economies, though they fell by a significant amount between 2000 and 2009. The sectors where indirect tariffs had the largest impact were construction, transport and storage, and other business activities. For OECD economies, indirect tariffs on services were highest on hotel and restaurant services, where they actually increased over the period, and construction services. These services industries are more reliant on inputs from goods sectors, some of which are sourced from abroad and subject to import duties. The lowest indirect tariffs were found in finance and insurance and in

real estate activities, where a larger share of intermediate inputs originates from other services. For instance, intermediate inputs from agriculture, mining and manufacturing combined accounted for 23% of the value-added of construction services and 18% of the value-added of hotel and restaurant services on average in 2009, but less than 5% of the value-added of financial and real estate activities.

Between 2000 and 2009, indirect tariffs on services dropped significantly in the sectors where they were highest, most likely as a result of reductions in import tariffs in upstream production stages. However, this drop may also be partially due to the consolidation of value chains and the decline in the construction sector which occurred in many economies in the wake of the 2008 financial crisis, and which may not be sustained in the longer run. Regarding R&D services, an interesting contrast appears between services imported by OECD members and by the BRIICS. While the former have seen reductions in indirect tariffs between 2000 and 2009, albeit from a very low starting point, there have been modest increases in the cost of tariffs embodied in R&D services imports by the BRIICS. A possible explanation is the rising sophistication (and a rising intensity in equipment and technology) of services used by firms from large emerging economies.

Conclusion

This case study has illustrated the interdependencies between trade in goods and trade in services. Since services are inputs into the production of goods and use manufacturing goods as intermediate inputs, the cost of barriers to goods trade also affects the competitiveness of services suppliers and services exporters. In global value chains, as tariffs are paid on the full value of a good at each border crossing – including the value added by intermediate goods and services – the effect of tariff costs on prices and demand is magnified for upstream services providers as well as for goods producers. A GVC perspective therefore shows that the cost of protectionist policies goes well beyond the sectors they directly target. It also highlights the gains that service sectors can reap from a liberalisation of trade in goods and vice versa.

Although the estimates presented here only relate to import duties, the same analysis and conclusions should apply to non-tariff trade costs. Slicing up the origin of value-added in trade flows reveals that goods and services trade are increasingly independent and barriers to the free flow of goods or services at one point of a global value chain are likely to affect the competitiveness of the whole GVC. Technical barriers to trade in manufacturing goods affect services suppliers in the same way as tariffs do; similarly, regulatory barriers to trade in services can raise costs or reduce the ability to export for manufacturing goods producers upstream and downstream in the value chain.

Case study 2: Removing input tariffs to improve export competitiveness: The experience of Canada

When production is internationally fragmented, exporters often rely on imported intermediate inputs to be competitive. One of the key implications of global value chains for trade policy is thus that a tax on imports is, even more than was previously understood, a tax on exports (OECD, 2013). Protectionist policies designed to shelter "domestic" producers from global competition may in fact undermine their competitiveness. This is especially true in a world where international competitiveness increasingly relies not only on cost but also on the ability of firms to innovate and produce high-quality products, which in turn requires unimpeded access to world-class intermediate inputs and state-of-the-art technology.

Removing one's own barriers to foreign products then becomes a means to increase participation in GVCs rather than a concession to trade partners.

Unilateral liberalisation measures undertaken recently by Canada provide an interesting policy application of this principle. In March 2010, Canada unilaterally decided to eliminate tariffs on a broad range of manufacturing inputs, machinery and equipment. The decision was part of an action plan in favour of jobs and growth. It followed a first reduction of MFN tariffs to zero on 214 tariff lines, accounting for over CAD 2 billion in annual dutiable imports in January 2009. The 2010 tariff elimination covered 1 541 tariffs, most of them removed immediately and 381 gradually until 2015. More than CAD 7 billion of previously dutiable imports will have become tariff-free when the tariff elimination is fully implemented. The Canadian government also planned to identify further areas for tariff relief in consultation with Canadian businesses. At the end of the implementation period, Canada will be the first G20 economy in which manufacturers operate without tariffs on inputs or imported machinery and equipment.

The reform was destined to lower the costs and improve the productivity and competitiveness of Canadian manufacturers. It is expected to provide CAD 410 million in annual duty savings for Canadian business and result in the creation of up to 12 000 jobs over time.[4] The first source of anticipated gains for manufacturers is reduced costs. The tariff reliefs decided in 2009 and 2010 will lead to the elimination of tariffs on over 40% of MFN applied dutiable tariff lines and close to 15% of dutiable imports, compared to the pre-2009 situation. This will result in direct cost savings for Canadian firms that purchase manufacturing inputs and machinery and equipment from foreign sources not yet benefitting from preferential exemptions. Additional cost savings come from the implied reduction in the administrative burden of complying with customs procedures; in particular as importing firms no longer need to document compliance with preferential rule of origin requirements and duty drawback conditions. Furthermore, an enhanced access to high-quality foreign inputs and equipment is expected to facilitate access to frontier technology and encourage innovation and investment, thus bolstering Canadian competitiveness in manufacturing sectors.

Several studies have highlighted the effects of input trade liberalisation on productivity and competitiveness. For instance, Amiti and Konings (2007), using plant-level Indonesian data, find that the productivity gains from reducing tariffs on intermediate inputs (a 10 percentage point fall in input tariffs is associated with a 12% productivity gain for importing firms) are at least twice as large as the gains from removing output tariffs. They suggest that the large productivity increases accrue from the technology embodied in imported inputs. Similarly, significant productivity gains from access to foreign intermediates and input tariff reductions are found for a variety of developing countries.[5] There are, however, few papers dealing with this issue in advanced industrial countries. Bas and Strauss-Kahn (2011) show that imported inputs have positive effects on French firms' productivity and their export performance. Focusing on the French agri-food sector, Chevassus-Lozza *et al.* (2013) also find evidence that input tariff reductions lead to a reallocation of export sales from less productive

4. http://actionplan.gc.ca/en/initiative/tariff-relief-manufacturing-inputs-and-machinery

5. Schor (2004) for Brazil, Kashara and Rodrigue (2008) for Chile, Topalova and Khandelwal (2011) for India, Halpern, Koren and Szeidl (2011) for Hungary, Feng, Li and Swenson (2012) for China, Bas (2012) for Argentina, and Stone and Shepherd (2011) for a cross-section of developing and transition economies. Goldberg *et al.* (2010) also estimate a significant impact of lowering input tariffs on domestic product growth.

to more productive downstream exporters, and raise export sales and employment at the industry level.

To date, analyses of the productivity impact of tariff liberalisation in Canada have mainly focused on the US-Canada free-trade agreement. In particular Trefler (2004) finds a large impact of Canadian and US tariff reductions on labour productivity at the industry level, and Lileeva and Trefler (2010) for plants that were induced to start exporting or export more. Both papers, however, focus on changes in output tariffs and do not consider the simultaneous reductions in input tariffs faced by Canadian firms. Caliendo and Parro (2012) estimate the gains from NAFTA tariff reductions in a Ricardian model. They find that the trade and welfare gains are largely underestimated if vertical trade and input-output linkages are ignored, highlighting the role of intermediate input trade in creating gains from trade liberalisation.

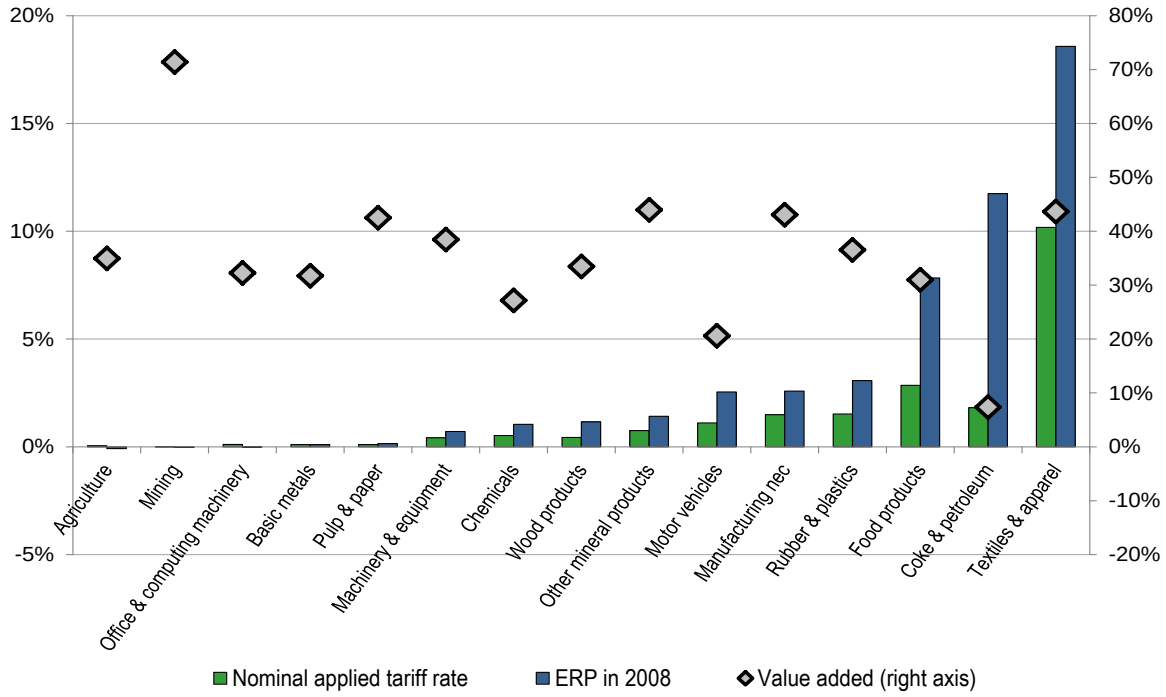
While the implementation of the reform is too recent to perform an extensive *ex post* analysis of its effects on the Canadian economy, this study provides first estimates of its expected impact on effective protection using information provided by the OECD ICIO model on each industry's use of foreign intermediate inputs. Simple estimates of the potential productivity increases that can be expected in Canadian industries as a result of their improved access to imported inputs are then presented.

The impact of input tariff reductions on effective rates of protection

Effective rates of protection (ERPs) are a useful tool to measure how the entire tariff structure of a country affects domestic firms active in a given industry. The nominal import duties levied on foreign counterparts to an industry's output do not provide a complete picture of protection. Their impact depends on how much value added effectively originates in the "domestic" sector, as well as on the tariffs applied to imported intermediate inputs. Input tariffs are in fact akin to negative protection for downstream industries as they raise the production costs of imported input users. ERPs calculate the comprehensive impact of all tariff policies affecting a sector, taking into account both tariffs on output – which protect the sector's producers – and tariffs on inputs purchased by these same producers (see Annex B for details).[6]

6. See Annex B for details.

Figure 7. Pre-reform nominal and effective protection rates in Canada, 2008



Source: Author's calculations using the OECD ICIO model and TRAINS.

The nominal and effective protection rates in 2008, prior to the first phase of the elimination of input tariffs, are shown on Figure 7. Nominal tariff rates are average applied tariff rates by industry, taking into account preferential agreements and weighting each product and partner by their shares in Canadian imports.[7] ERPs are calculated based on nominal tariff rates on inputs and outputs and sourcing shares from the 2008 global input-output table.[8]

Before the elimination of tariffs on manufacturing inputs and equipment was put in place, there were wide variations in the extent of protection awarded to different manufacturing industries. Very low nominal protection in the mining and office equipment industries resulted in small negative ERP rates as firms in these sectors faced positive tariffs on some of their intermediate inputs. At the other end of the scale, the textile industry was the most protected one, with an average applied nominal rate of 10% and an ERP approaching 19%. Interestingly,

7. Owing to lack of data, the analysis does not reflect duty deferrals and exemptions.

8. ERPs are typically higher than nominal MFN rates, for two reasons. On the one hand, tariffs on raw materials and intermediate goods tend to be set lower than tariffs on processed and finished goods. On the other hand, the mere fact that a sector uses intermediate inputs, be they domestic or foreign, amplifies the impact of a given tariff when we measure protection relative to value-added rather than output, through the denominator in the definition of the ERP. This effect captures the fact that the degree of protection awarded to a sector, for a given nominal tariff imposed on its foreign counterparts, is higher when the domestic producer contributes a small share of the total value added of its output. For instance if value-added in the sector accounts for 50% of the total value of its output, a 10% tariff on output (without any input tariff) would imply that the domestic producer's own labour and capital expenditures could be as much as 20% higher than those of foreign producers and it would still be charging lower prices in the domestic market.

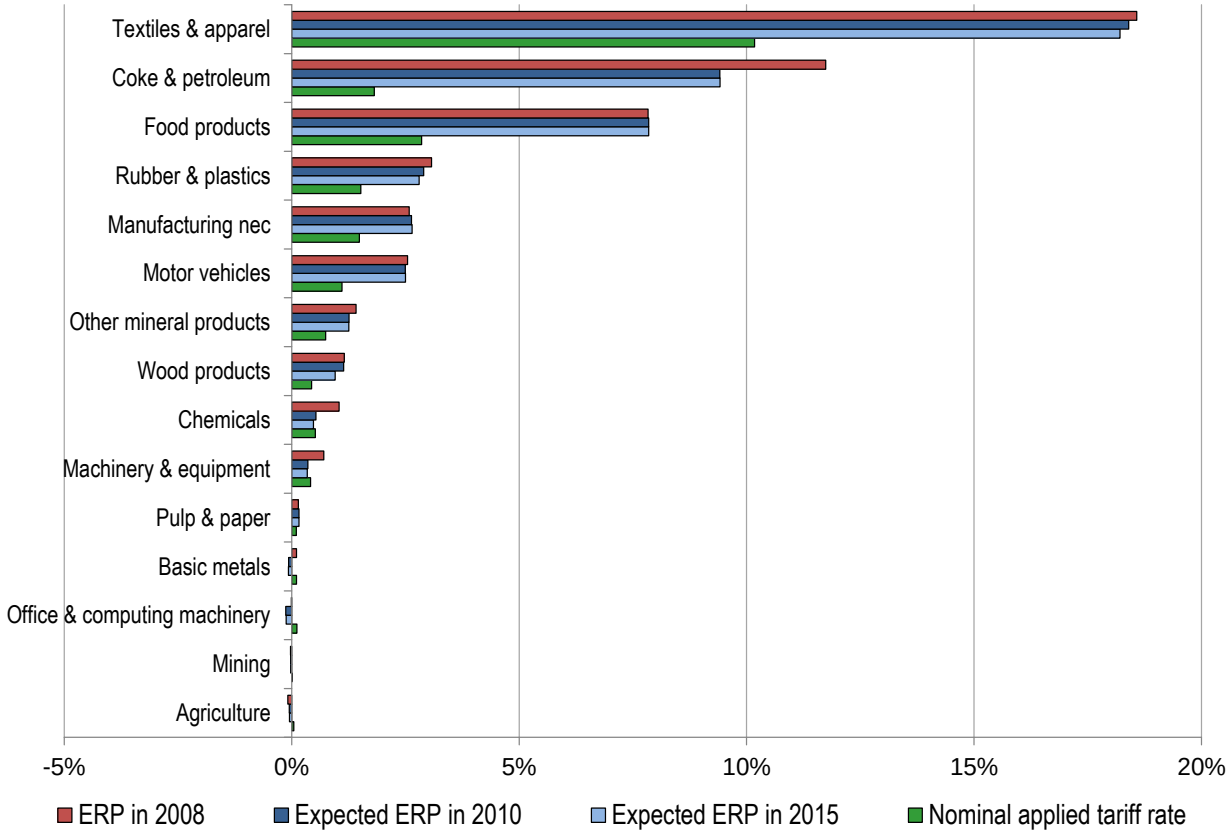
differences in ERPs across sectors are not only explained by nominal rates. Industries that contribute a small share of the value of their output – such as coke and refined petroleum or food products – have relatively higher ERPs despite low nominal tariffs. Industries with a larger share of sectoral value-added, such as rubber and plastics, and using more inputs sourced either domestically or from free trade partners, have relatively lower ERPs. In services sectors (not shown), ERPs are negative, as there are no tariffs on services imports but services suppliers use dutiable imported inputs, but very small.

Figure 8 presents the expected changes in ERPs as Canada switches to duty-free imports of most manufacturing inputs. The post-reform ERPs are calculated for each phase of implementation (MFN tariff reduced on some tariff lines and set to zero on others in 2010; MFN tariff reduced to zero on all concerned tariff lines in 2015).[9] The production structure, including the strength of input-output linkages, is assumed to be constant in order to isolate the impact of the policy. After the tariff relief is fully implemented, most sectors will have lower effective protection. Among manufacturing sectors, the largest decline in ERPs takes place in the coke and petroleum industry. The output of this sector largely consists of intermediate products used in further stages of production; the new policy therefore exposes it more intensely to the competition of imported inputs.[10] Effective protection on textiles, motor vehicles and rubber and plastics drops by a lesser amount. The ERPs on chemicals and on machinery and equipment, two sectors that primarily serve downstream industries rather than final demand, are expected to fall by half, but from low initial levels. Finally, food products is the third most protected industry, with initial nominal tariffs of 2.9% on average and initial ERPs of 7.9%. The effective protection in the sector is, however, unaffected by the new trade policy environment. Producers of food products are generally closer to final demand than in other manufacturing sectors and do not compete directly with imported manufacturing inputs; though they will benefit from lower tariffs on their imported inputs and equipment, this gain is not expected to be significant.

9. The relevant tariff notices are available on the Canada Border Services Agency website: www.cbsa-asfc.gc.ca/trade-commerce/tariff-tarif/2009/tn38-eng.html and www.cbsa-asfc.gc.ca/trade-commerce/tariff-tarif/2010/tn49-eng.html.

10. However, as the level of aggregation of the input-output data does not allow us to distinguish varieties at the product level, the calculation is likely to overstate the extent of direct competition – rather than vertical complementarities – between domestic and foreign products.

Figure 8. ERPs in Canada before and after the elimination of input tariffs



Source: Author's calculations using the OECD ICIO model and TRAINS.

Improved access to foreign intermediate inputs and productivity

Productivity channels

Beyond the impact of the reform on the openness of various sectors, its success will hinge on the extent to which it improves the competitiveness of downstream sectors and creates jobs. There are several possible channels through which lower tariffs on intermediate inputs and equipment are likely to raise manufacturing productivity. First, the immediate effect of the tariff removal is to provide Canadian firms with a greater choice of input sources at a competitive cost, allowing them to save on costs or upgrade the quality of their imported intermediate goods. Prices will fall both on imported and domestically sourced intermediates, as domestic producers of inputs are expected to adjust their prices in a more competitive environment and pass on their cost savings on their own inputs. Lower production costs will in turn allow Canadian manufacturers to improve the price competitiveness of their products on international markets. Further cost savings can arise from scale economies as manufacturing firms expand their volume of production.

Second, better access to foreign intermediate inputs and capital goods provides the using industries with the opportunity to benefit from, and learn from, the technology embodied in imported inputs. As innovation is essential to any competitiveness strategy in many manufacturing industries, the increased availability of specialised intermediate goods can give Canadian firms a competitive edge. Access to better-quality inputs also facilitates quality

upgrading, reduces the number of defects and improves the efficiency of the production process.

In the long run, productivity gains are expected to be larger than in the short-run as industries and firms adjust their production structure to the new tariff environment. At the industry level, a shift in the allocation of resources and sales from lower-productivity to higher-productivity firms is expected to boost the average productivity of both upstream and downstream industries. Within plants, as long as there is some substitutability between inputs, Canadian firms should rely more on imported intermediates, the after-tariff price of which is likely to fall in the duty-free categories. Such reallocations will raise the share of tariff-free inputs in the production structure and amplify the gains induced by the policy for firms outsourcing inputs.

Tariffs, imported input demand and productivity

To assess the potential impact of the elimination of tariffs on manufacturing inputs and equipment, we first test to what extent the share of foreign intermediates is likely to rise, that is, to what extent imports of such inputs and equipment are responsive to tariff rates. Table 1 shows the estimated sensitivities of Canada's bilateral imports (in logs) to tariff rates at the product level, estimated over the pre-policy period ranging from 1995 to 2009. There is no significant relationship between tariff rates and the volume of imports for consumption goods and capital goods, but a strong negative relationship for intermediate goods. When distinguishing between products which are covered by the tariff elimination and products which are not, we also find that the demand for imports of the former is significantly affected by tariff rates, but demand for the latter is not. This confirms, in Canada's case, earlier findings according to which trade in intermediate goods is more sensitive to trade costs than trade in final goods (e.g. Miroudot *et al.*, 2009). The coefficients from these first estimations would imply that a 1 percentage point reduction in tariffs is associated with a 3.6% increase in imports for products covered by the tariff relief policy, and with a 3.7% increase in imports for intermediate goods in general (bottom of Table 1). As the average applied tariff rate on products covered by the tariff relief was 2.8% in 2008, this implies a potentially large rise in the use of foreign intermediate inputs by Canadian manufacturers.

Table 1. Import sensitivity to tariff rates, Canada, by category of imports

	Log imports	Log imports	Log imports
Tariff	0.006 (0.008)	-0.002 (0.012)	0.006 (0.009)
Tariff*Relief		-0.035*** (0.004)	0.001 (0.013)
Tariff*Intermediate	-0.043*** (0.004)		-0.044*** (0.009)
Tariff*Capital	-0.023 (0.032)		-0.023 (0.031)
Implied coefficient: Relief		-3.593	
Implied coefficient: Intermediate	-3.690		-3.716

Source: See Annex B for data sources and detailed specification. The observations cover 1995-2009 for 5219 6-digit HS products and 186 partners. The dependent variable is log bilateral imports. Tariffs are applied tariff rates for the industry, averaged over products and partners and expressed in percentage points. Intermediate and Capital are variables that take a value of 1 is the imported product is, respectively, an intermediate good and a capital good, where each 6-digit HS product is classified by end-use according to the classification of the TiVA database. Relief is a variable that takes value 1 if the product is covered by the 2009-2010 tariff relief program, and 0 otherwise. Standard errors are adjusted for clustering by sector. All regressions include the logarithm of GDP as a control variable as well as year, partner and ICIO sector fixed effects. Standard errors are in brackets.

Next, the relationship between openness to foreign inputs and productivity is estimated at the industry level (30 sectors), again over a pre-policy period 1995-2008. Several measures of productivity are considered: multifactor productivity (MFP) and labour productivity per hour, each calculated based either on the gross output or the value added of the industry, from Statistics Canada's Productivity Accounts. The first column of Table 2 presents the baseline specification. The main results for productivity mirror those of Table 1 for imports: the relationship between tariffs and MFP holds only in industries where a significant share of imports consists of intermediate goods. In industries where the intermediate share is high, lower tariffs are associated with higher MFP. Though these results are still exploratory and obtained at a fairly aggregated industry level, they provide evidence in favour of the argument that imported inputs enhance efficiency in production and/or bring embodied technology. A similar result is found if MFP is measured from gross output statistics, though the coefficient is smaller. This can be partly explained by the fact that lower input prices translate into higher value-added if the cost savings are not fully passed through to output prices. When labour productivity measures are used, we obtain a positive coefficient on tariff rates for industries where the imported intermediate share is smaller. As no such effect is found for MFP, this is likely due to differences in the bundle of capital, labour, materials and services inputs. In particular, a positive coefficient can reflect larger tariff reductions in industries where there was less substitutability between labour and other factors. Therefore, the results on multifactor productivity, which take into account the substitution between types of inputs, are preferred.

Table 2. Tariffs and productivity by industry, Canada

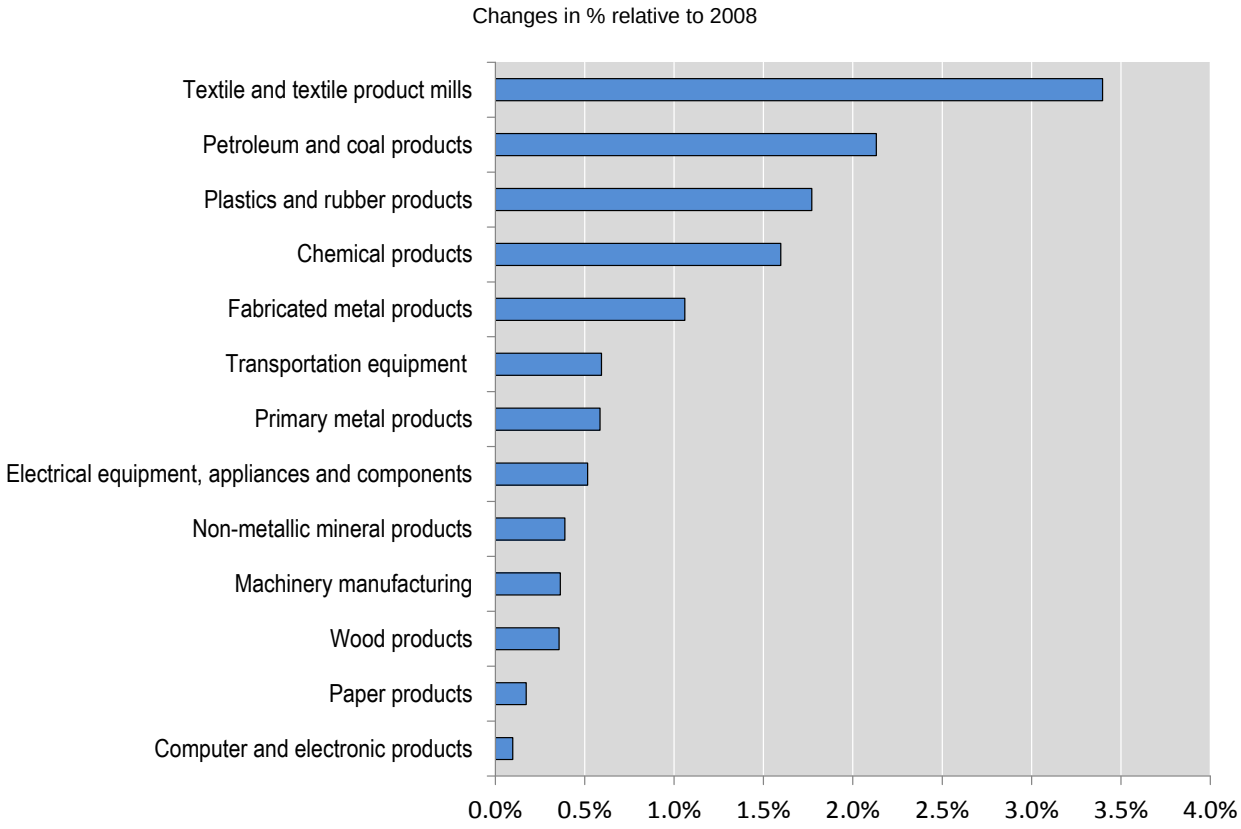
	Multifactor productivity based on value added	Multifactor productivity based on gross output	Labour productivity based on value added	Labour productivity based on gross output
Tariff	1.052 (0.817)	0.314 (0.359)	3.000*** (0.843)	2.079*** (0.692)
Tariff*Intermediate share	-2.784** (1.180)	-0.998* (0.519)	-2.793** (1.217)	-1.880* (0.999)
Tariff*Capital share	-0.970 (3.005)	-1.372 (1.321)	-1.505 (3.101)	-3.441 (2.544)
Intermediate share	85.773** (41.434)	38.490** (18.223)	79.303* (42.759)	29.664 (35.081)
Capital share	45.662 (115.147)	39.657 (50.642)	98.404 (118.830)	25.873 (97.492)

Source: See Annex B for data sources and detailed specification. The observations cover 1995-2008 for 30 sectors (350 observations). Tariffs are applied tariff rates for the industry, averaged over products and partners. Intermediate share and Capital share are the shares of intermediate goods and capital goods by sector of imports, where each 6-digit HS product is classified by end-use category as in the TiVA database. All regressions include year and sector fixed effects. Standard errors are in brackets.

Lastly, we estimate the potential gains in MFP from the tariff elimination at the industry level (based on the results of column 1 of Table 2; only selected manufacturing industries are shown). The estimated productivity gains shown on Figure 9 are calculated under the assumption that there are no other changes in the economic environment, to isolate the effect of the policy. The largest potential gains accrue to the textile industry (3.4% relative to 2008), followed by petroleum and coal products manufacturing (2.1%), plastics and rubber products (1.8%) and chemicals (1.6%).[11] These potential productivity increases would be sizeable considering the modest initial levels of Canada's intermediate input tariffs, which strengthens the case for "going the last mile" in the elimination of import duties.

11. The corresponding numbers for MFP based on gross output are lower but remain significant.

Figure 9. Estimated multifactor productivity gains for selected industries, Canada



Source: Author's calculations using data from Statistics Canada, the OECD ICIO model and TRAINS.

Conclusion

This case study analysed the tariff relief policy put in place by Canada on manufacturing inputs and machinery, and its potential impact on effective openness and productivity. It suggests that the policy will lower effective protection in most sectors and significantly increase access to foreign intermediate goods. This greater availability of specialised inputs and machinery equipment is likely to reduce production costs, improve efficiency in production processes and enhance the ability to innovate in downstream manufacturing industries, bolstering their own external competitiveness. The first estimates of expected productivity gains differ across industries but are found to be relatively strong in a number of sectors.

The expected gains can be further boosted by a rise in foreign investment in Canada. The absence of tariffs on imported inputs is likely to encourage firms to locate downstream production sites in Canada to enjoy the cost savings of importing intermediates from countries outside the existing networks of Canada's free trade agreements. It could become more profitable to open production facilities in Canada to serve not only the domestic market but also the rest of North America and other markets. Though it is too early to assess the long-run efficiency and employment gains generated by the policy, they are therefore expected to exceed the short-run gains.

Canada will not be the only one to benefit from the policy change. Its partner countries will also gain. On the one hand, foreign input producers supplying Canadian firms directly or

indirectly will see their market access increase. On the other hand, the cost savings of the tariff removal will be transmitted down the value chain to foreign firms purchasing intermediate goods from Canadian suppliers and thus raise productivity throughout the GVCs in which they participate.

Case study 3: The Information Technology Agreement and global value chains

The Information Technology Agreement (ITA) was the first sectoral goods agreement to be successfully negotiated at the WTO (WTO, 2012). It has removed tariffs on key technology and telecommunications products, initially for 29 signatories and now for 78 countries (covering 97% of world trade in information technology products). Although the agreement is plurilateral, its benefits apply to all WTO Members because it is based on the Most Favoured Nation (MFN) principle. As the ITA covers a wide range of products along the ICT value chain, it is often cited as an example of how trade agreements can play a positive role in the vertical specialisation of firms and promote the development of GVCs (Baldwin, 2006; Kimura and Obashi, 2011).

Evidence on GVCs in the industries covered by the ITA

The ITA provides that "each party shall bind and eliminate customs duties and other duties and charges of any kind" on a list of 190 products. These products are defined in two ways in the agreement. Some of them are listed in Attachment A with a reference to the 1996 Harmonized System (HS) nomenclature, while others are described in Attachment B "wherever they are classified in the HS". The absence of reference to specific HS lines for some products and changes introduced by subsequent revisions of the HS nomenclature complicate the analysis of the ITA coverage.[12] Nevertheless, Table 3 below maps the HS lines covered by the agreement to the industries of the OECD Inter-Country Input-Output model. In addition, we apply the UN Broad Economic Categories (BEC) classification to distinguish the lines covering primarily intermediate inputs from those corresponding to final goods.

12. However, some work has been done by the WTO and the World Customs Organization (WCO) to provide HS codes for products listed in Attachment B, as well as to transpose to more recent versions of the Harmonized System the codes from Attachment A.

Table 3. ITA coverage, by ISIC industry

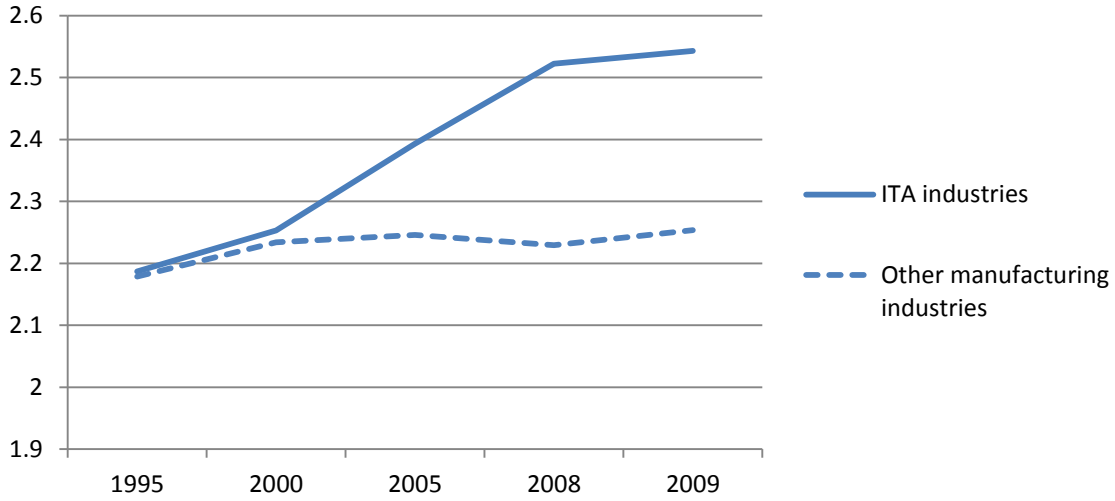
ISIC code	Industry name	Total number of HS lines covered (HS96)	Number of HS lines partially covered	Distribution by ISIC industry (%)	Number of lines covering mainly intermediate inputs	Intermediate inputs as a percentage of covered HS lines
ISIC21_22	Pulp, paper, paper products, printing and publi	5	1	3.3%	4	80.0%
ISIC24	Chemicals and chemical products	5	0	3.3%	2	40.0%
ISIC26	Other non-metallic mineral products	1	1	0.7%	1	100.0%
ISIC29	Machinery and equipment n.e.c	24	24	15.7%	8	33.3%
ISIC30	Office, accounting and computing machinery	25	1	16.3%	5	20.0%
ISIC31	Electrical machinery and apparatus n.e.c	16	12	10.5%	9	56.3%
ISIC32	Radio, television and communication equipme	51	8	33.3%	27	52.9%
ISIC33	Medical, precision and optical instruments	26	12	17.0%	7	26.9%
	Total	**153**	**59**	**100%**	**63**	**41.2%**

Source: Authors' calculations on the basis of WT/MIN(96)/16, Attachment A.

Most of ITA goods are found in the "Radio, television and communication equipment" industry (ISIC 32), followed by "Medical, precision and optical instruments" (ISIC 33), "Office, accounting and computing machinery" (ISIC 30), "Machinery and equipment not elsewhere classified" (ISIC 29) and "Electrical machinery and apparatus not elsewhere classified" (ISIC 31). These five sectors can be used to define the IT industry. On average, 42% of the listed HS lines correspond to intermediate inputs. The ITA covers mainly trade in final goods, but key inputs are also included in the agreement, in particular in the "radio, television and communication equipment" industry. With the exception of a few chemical elements, these inputs are essentially parts and components for electrical machinery or equipment, in particular semi-conductors.

It is not a coincidence that global value chains are particularly strong in the industries covered by the ITA. Figure 10 points out that in the five industries listed above (ISIC 29 to ISIC 33), the length of value chains has increased at a steadier pace between 1995 and 2009 as compared to other manufacturing industries. It is also interesting to note that in 1995 and 2000, this index which assesses the number of production stages in a given value chain (including both the domestic and international part of the value chain) had similar values in IT industries as compared to other manufacturing industries. One could see in the trend observed beyond 2000 the impact of the implementation of the ITA. The expansion of IT global value chains coincides with the entry into force of the agreement in 1997 (Anderson and Mohs, 2011).

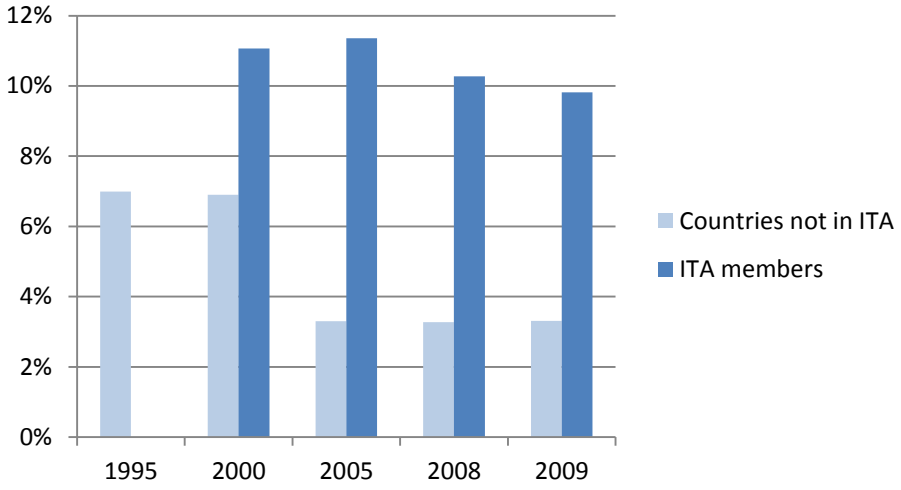
Figure 10. Index of the length of global value chains, ITA industries versus other manufacturing industries, 1995 to 2009



Source: De Baker and Miroudot (2013) using the OECD ICIO model. "ITA industries" are defined on the basis of Table 3 as "Machinery and equipment n.e.c." (ISIC 29), "Office, accounting and computing machinery" (ISIC 30), "Electrical machinery and apparatus n.e.c." (ISIC 31), "Radio, television and communication equipment'"(ISIC 32) and "Medical, precision and optical instruments" (ISIC 33).

Further evidence of an "ITA effect" on global value chains can be found by looking at Figure 11 which shows a GVC participation index for ITA members and countries that are not party to the ITA. This participation rate is calculated as a percentage of gross exports and measures both the use of foreign inputs in exports (backward participation) and the use of domestic intermediate inputs by other countries for their exports (forward participation). Before the entry into force of the agreement, the average participation rate for all countries was about 7%. The first members of the ITA had a higher participation rate in 2000 (11%) and despite a slight decrease over time when new members joined, the participation index remains much higher than for non ITA members. Figure 11 does not provide evidence of a causal link and technological advances may also explain some of the trends observed in trade patterns and firm strategies. But ITA members are definitely more involved in GVCs than non-signatories.

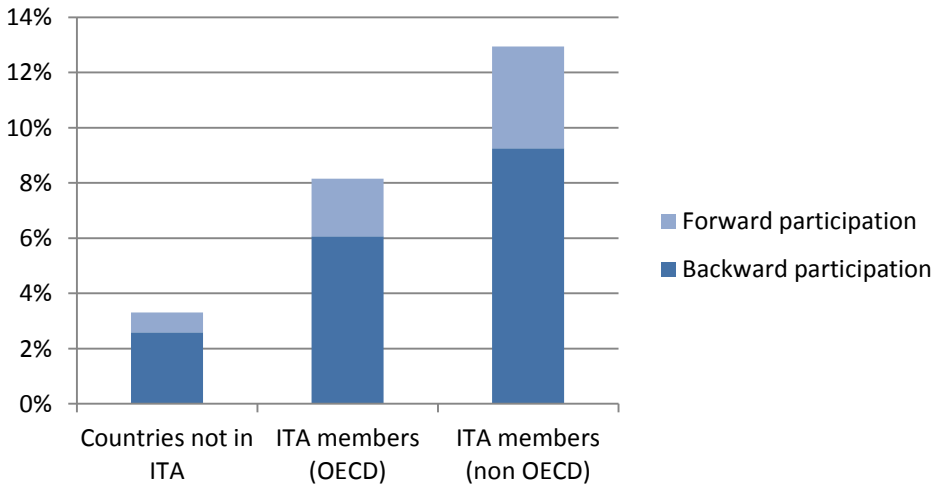
Figure 11. ITA membership and participation in IT GVCs, participation index as a percentage of gross exports, 1995 to 2009



Source: De Baker and Miroudot (2013) using the OECD ICIO model. "ITA industries" are defined on the basis of Table 3 as "Machinery and equipment n.e.c." (ISIC 29), "Office, accounting and computing machinery" (ISIC 30), "Electrical machinery and apparatus n.e.c." (ISIC 31), "Radio, television and communication equipment" (ISIC 32) and "Medical, precision and optical instruments" (ISIC 33).

It is also interesting to point out that developing countries that have joined the ITA have on average a higher participation index in IT value chains than OECD countries. Figure 12 shows that the average participation in 2009 is 13% for non OECD ITA members, as opposed to 8% for OECD ITA members. These developing countries are as much relying on imported inputs (backward participation) as providing inputs for third countries' exports (forward participation), as compared to OECD countries.

Figure 12. ITA membership, backward and forward participation in IT GVCs, as a percentage of gross exports, 2009



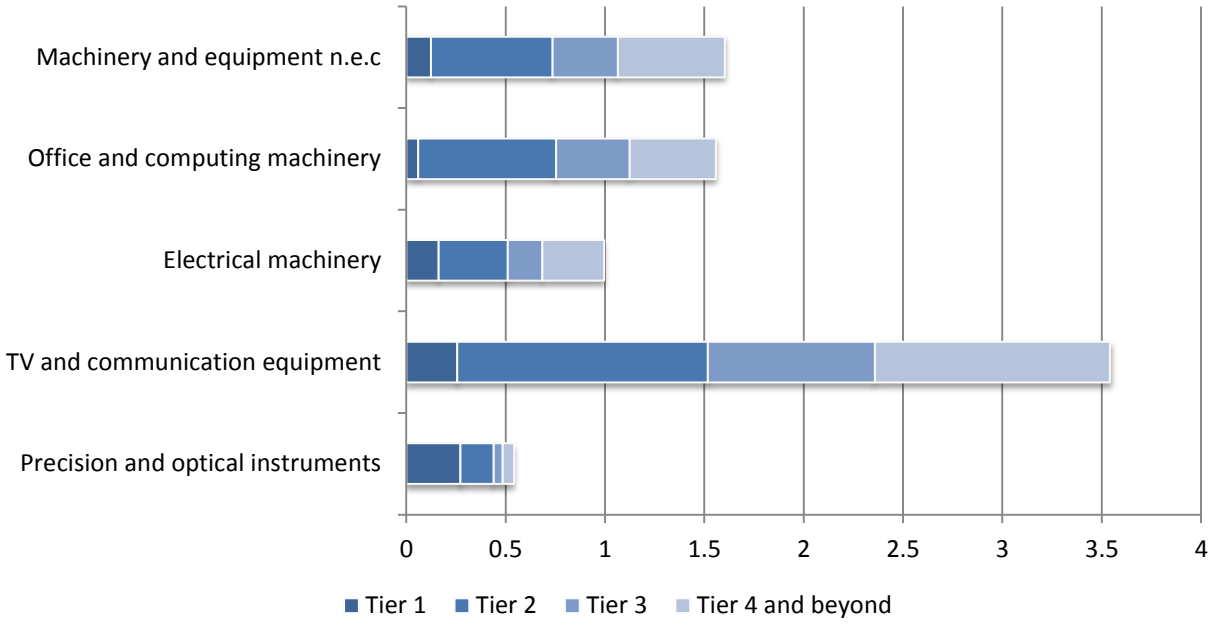
Source: De Baker and Miroudot (2013) using the OECD ICIO model. "ITA industries" are defined on the basis of Table 3 as "Machinery and equipment n.e.c." (ISIC 29), "Office, accounting and computing machinery" (ISIC 30), "Electrical machinery and apparatus n.e.c." (ISIC 31), "Radio, television and communication equipment" (ISIC 32) and "Medical, precision and optical instruments" (ISIC 33).

Cumulative tariffs in the IT value chain

Using the concept of cumulative tariffs introduced in the previous case studies, we can further analyse the impact of the ITA by looking at average tariffs in the industries producing the goods covered by the agreement, as well as upstream industries.

To understand how tariffs upstream impact the IT value chain, we can first use the theoretical and empirical framework described in Section 1. Figure 13 below introduces a decomposition of cumulative tariffs across the IT value chain, starting with IT producers and looking upstream at their first-tier suppliers, second-tier suppliers, third-tier suppliers and so on, until the full cumulative tariff is reached. The average by industry is calculated on the basis of all ITA members for whom we have detailed input-output information in the OECD ICIO model (weighted by their share in overall output). These tariffs have been levied on different input producers (belonging to all types of industries) but are expressed as a percentage of the value of the product at the end of the chain (in the IT industry under consideration).

Figure 13. Decomposition of cumulative tariffs on intermediate inputs in IT industries, 2009



Source: Authors' calculations using the OECD ICIO model, TRAINS and Comtrade. Average across ICIO countries weighted by their value added share.

One can see that despite low tariffs at the end of the chain due to the ITA, tariffs upstream are still non-negligible and that there are marked differences among the five industries represented. Cumulative tariffs are much higher in the TV and communication equipment industry as opposed to other industries. "Precision and optical instruments" is the industry with the lowest cumulative tariff. For an industry such as "Office and computing machinery", tariffs on the parts and components directly imported by final producers have almost disappeared, but still the cumulative tariff is significant and is mostly derived from the duties paid by second-tier suppliers. While tariffs are expected to represent a smaller and smaller share of the value of the good when going upstream (because upstream inputs represent a

smaller share of the value of the IT good at each stage), what is interesting with the IT value chain (and different from other value chains) is that indirect tariffs upstream weigh more than direct tariffs on the inputs directly imported by IT producers.

On the one hand, this can be interpreted as the success of the ITA and the effective removal of tariffs for IT industries. On the other hand, it highlights the limitations of a sectoral approach, focusing on IT inputs and not being extended to other inputs that are used further upstream in the value chain. In the case of the TV and communication equipment industry, for example, fourth tier suppliers and suppliers beyond are bearing relatively higher tariffs than in other industries on which the ITA has no impact. Reducing tariffs along the full IT value chain would involve going far beyond the list of IT products covered by the ITA.

It is beyond the scope of this paper to indicate which products could be added to the ITA list or to suggest a perimeter for the "IT value chain". But the information collected at the HS 6-digit level to calculate cumulative tariffs can be used to provide an illustration of the products found upstream that explain the results of Figure 13. As the OECD ICIO is built at a higher level of aggregation for products, Table C.3 in the annex should be seen as an illustration since we cannot fully account for specific input-output relationships at the product level.

The results are nonetheless interesting. For each industry and for each tier of suppliers, Table A.5 reports the top six intermediate products that drive the cumulative tariffs described in Figure 13. Values are averaged across countries and the rank of each product is determined by the weight of the industry in the input-output table (with weights lower and lower when moving upstream), the weight of the HS6 product within the supplying industry (based on imports) and the bilateral tariffs at the HS 6-digit level (from the tariff matrix we have constructed for intermediate inputs). One can see in each industry the shift in the type of goods supplied when moving upstream. For example, in the case of the precision and optical instruments industry, products with the highest weighted tariffs that are imported in the first stage of production (by manufacturers and exporters of such products) are typically optical fibres, lenses and mirrors. When moving upstream to the companies providing these inputs and their suppliers, there is gradually a shift to more generic inputs, such as petroleum oils or products of iron and steel, which are less specific to the IT industry. Parts of motor vehicles even appear in the list when looking at tier 4 imports and beyond because input suppliers rely on motor vehicles that have to be manufactured and enter the IT value chain upstream.

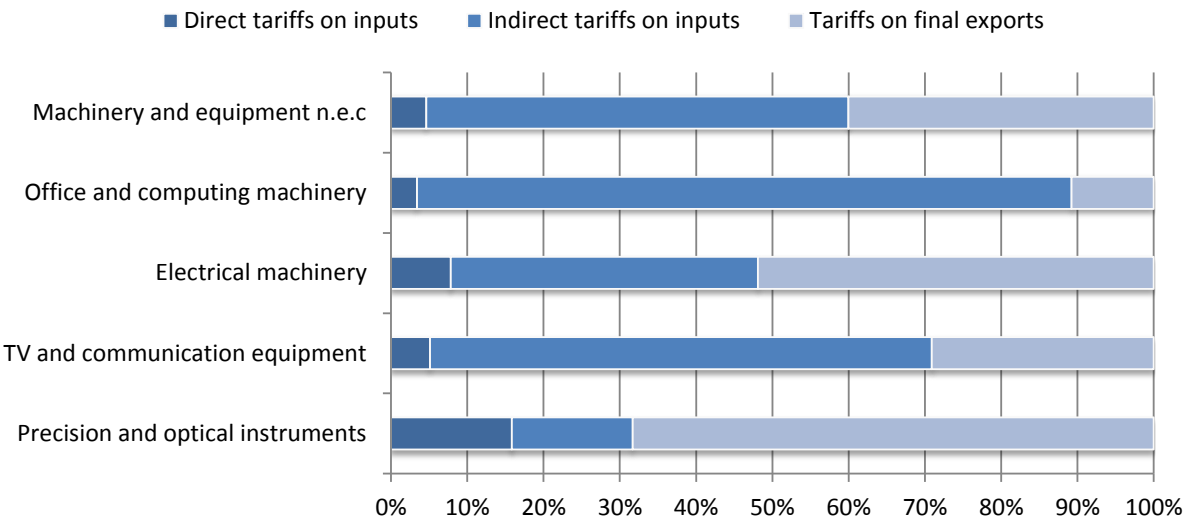
Table A.5 also highlights that there are products used in most manufacturing industries, such as petroleum oils and lubricants, which are not found at a specific stage of production but rather horizontally and used by most tiers of suppliers. It implies that the results in Figure 13 are not only driven by the types of products across the value chain but also by their mix in the different stages of production (i.e. their importance as a share of intermediate inputs use at each stage). This is also the case for quite generic inputs such as flat-rolled products of iron and non-alloy steel.

Figure 13 shows only the cumulative tariff on inputs for producers both of IT intermediate inputs and IT final goods. In Figure 14, we go one step further by examining the production of an IT final good that is exported. As previously emphasised, most of the products covered by the ITA are final goods. In addition to the duties levied on their imports of intermediate inputs, IT producers face tariffs on their exports and we can give an even fuller picture of the incidence of tariffs on the IT value chain by adding the tariffs on final exports.

Figure 14 illustrates the IT "tariff value chain", indicating the share of direct tariffs on imported inputs, indirect tariffs on intermediate goods and services embodied in imported

inputs and tariffs on final goods. The values for each industry and the total cumulative tariff can be found in Table 5. Figure 14 gives a different perspective on the weight of tariffs in IT trade. There are two opposite cases with "Precision and optical instruments" on the one hand and "Office and computing machinery" on the other hand. In the latter, tariffs are mostly indirect tariffs on inputs, while tariffs on direct inputs are very low and tariffs on final exports are also limited. In the former, the bulk of the costs derived from tariffs is mostly in the final stage of production, when exporting the IT good to final consumers.

Figure 14. The IT tariff value chain, 2009: Share of tariffs on direct imports of inputs, indirect imports of inputs and exports of final good



Source: Authors' calculations using the OECD ICIO model, TRAINS and Comtrade. Average across ICIO countries weighted by their value added share.

With a total cumulative tariff higher than 5%, "Radio, television and communication equipment" is the GVC where custom duties are the heaviest. Interestingly, this is also the industry where most of ITA HS lines are found (about one third, see Table 3). Figure 14 provides an explanation: almost 65% of these tariffs come from customs duties levied in industries upstream (indirect tariffs on inputs) that are not covered by the ITA. Moreover, inputs can be imported from countries that are not participants to the ITA.

Table 4. Average ad valorem tariffs along the IT value chain, 2009

ISIC code	Industry name	Average direct tariff on inputs (A)	Average indirect tariff on inputs (B)	Average tariff on final goods (C)	Average tariff along the full value chain (A)+(B)+(C)
ISIC29	Machinery and equipment n.e.c	0.1%	1.5%	1.1%	2.7%
ISIC30	Office, accounting and computing machinery	0.1%	1.5%	0.2%	1.7%
ISIC31	Electrical machinery and apparatus n.e.c	0.2%	0.8%	1.1%	2.1%
ISIC32	Radio, television and communication equipment	0.3%	3.3%	1.5%	5.0%
ISIC33	Medical, precision and optical instruments	0.3%	0.3%	1.2%	1.7%

Source: Authors' calculations using the May 2013 release of the OECD ICIO model, TRAINS and Comtrade. Average across ICIO countries weighted by their value added share.

Conclusion

There is ample evidence that global value chains for IT products are more developed and that countries which have signed the ITA are more involved in this type of GVCs. It is difficult to assess the causal direction as countries producing and specialising in IT products were the ones interested in an ITA in the first place. Moreover, the IT sector is characterised by rapid technological progress and new products have an impact on trade patterns and strategies of firms. Nevertheless, the removal of tariffs for a broad number of IT goods, both on intermediate inputs and final products, can only have played a positive role in the reduction of trade costs that explains the higher degree of vertical specialisation observed in the IT industry. ITA membership is especially associated with a high participation in GVCs for developing countries.

While the ITA is a good example of how a plurilateral agreement can benefit a particular industry, it is, however, still short from covering the full IT value chain. Discussions around the modernisation of the agreement have focused on how to update the list of products to cover recently developed IT technologies and products. Since 1997, the universe of IT products has radically changed with rapid technological advances. But what GVC analysis points out is that the costs derived from tariffs are mostly found upstream, particularly for "Office and computing machinery" and "TV and communication equipment".

Extending the ITA to cover all the inputs needed to manufacture IT products would of course involve going beyond IT industries. There is of course no harm in promoting duty free access for first-tier inputs (as long as no tariff escalation or effective protection is created along the way) but where a GVC combines inputs from an identifiable discrete set of industries, it would appear to be at least equally important to reduce trade costs for second-tier, third-tier and fourth-tier suppliers. The above analysis indicates that upstream tariffs add non-trivial costs to the production of IT goods. But where should the "IT value chain" stop when negotiating an agreement on IT products? Going upstream, one quickly encounters inputs that are common to several value chains and no longer specific to IT products. A sectoral agreement cannot be fully a GVC agreement, as the value chain encompasses all the raw materials and inputs upstream and cuts across industries.

Moreover, the ITA focuses on the removal of tariffs, while there are other issues that businesses would expect to be part of a global value chain agreement:

- First, the agreement is limited to trade in goods while services play an important role in any manufacturing value chain and more particularly for IT products. As explained with the first case study, services themselves can add indirect tariffs to the value chain. But more generally, gains can be expected from access to more efficient services inputs, whether through domestic reforms or through market access, and national treatment commitments that allow foreign suppliers to enter the market. One could see in the WTO Reference paper on Telecoms the services counterpart to the ITA but a broader range of services are needed by IT producers of goods, such as transport services, financial services or professional services.
- Second, investment and competition issues are not dealt with in the ITA. Any multilateral approach within the framework of WTO would appear to be difficult since these issues were dropped from the Doha Development Agenda following the Cancun Ministerial meeting in 2003. But authors who have suggested the negotiation of an "international supply chain agreement" (Nakatomi, 2012) highlight that it could be one way to introduce new disciplines that are relevant for global value chains.
- Lastly, there are also important Non-Tariff Barriers (NTBs) that affect trade in IT products. It should not be forgotten that the ITA encourages consultations on this issue and that since 1998 some work has been conducted within the WTO ITA Committee to review specific technical regulations, national safety standards, conformity assessment criteria, import licensing requirements, customs procedures and international standards in the IT industry (WTO, 2012). Dealing with the diversity of standards and streamlining administrative and customs procedures can also facilitate the expansion of IT global value chains.

Case study 4: Global production networks and regional trade agreements

The number of countries signing RTAs has increased dramatically since the early 1990s, rising from about 70 to nearly 354 by 2012.[13] Also, the coverage of these agreements has been broadening and deepening considerably over the last decades. More recent RTAs embody provisions on trade in services and other areas, such as investment, intellectual property, competition policy, trade facilitation or government procurement (WTO, 2013).

The previous case studies have stressed the importance of continuing to encourage policies that reduce trade barriers, particularly tariffs, where costs are cumulative (Yi, 2003) but they have also highlighted the importance of other non-tariff trade costs. Differences in administrative procedures, mandatory standards, infrastructures and institutional quality of countries impact on a company's ability to fully engage and benefit from GVCs. The development and expansion of GVCs has therefore increased the emphasis on reducing these non-tariff costs.

Do RTAs increase GVC participation or do GVCs themselves motivate the development of RTAs? It is difficult to assess the direction of any causal relationship. Most studies have explored whether RTAs promote GVCs, focusing on the impact of deeper integration on production networks.[14] A few studies have also tested empirically the opposite direction of

13. Under WTO rules, the goods and services aspects of RTAs are notified separately, therefore the RTAs are counted separately. If the two aspects are considered together, there are 235 RTAs currently in force by 2012 (WTO, 2013).

14. See for instance Lawrence (1996), Yi (2003), Baier and Bergstrand (2004 and 2007), Pomfret and Sourdin (2009) and Hayakawa and Yamashita (2011), Brooks and Ferrarini (2012).

causality, with mixed findings.[15] For example, UNESCAP (2011) and Menon (2013) argue that RTAs have played only a minor role in the expansion of GVCs, in particular in East and South-East Asia. Other authors have questioned the potential negative effects of uncoordinated RTAs on production sharing, and the risks of inconsistent regulations on GVCs (Feridhanusetyawan, 2005) leading to a "noodle-bowl" effect created by the overlapping of different rules of origin (Zhang and Shen, 2011; Baldwin, 2008).

It is beyond the scope of this case study to presume to determine the causal relationship between RTAs and GVCs. This case study aims more modestly at providing new evidence on the actual factual alignment of current trade agreements with global production networks. What is tested is the symmetry of the network of bilateral and regional free trade agreements of a given country with the strategies of its firms when it comes to sourcing inputs to produce goods and services that are exported (i.e. vertical trade).

Network trade and the network of trade agreements

To evaluate to what extent the widespread increase in RTAs matches the diffusion of GVCs, two indices are calculated. The first index provides a measure of the direction and intensity of countries' network relations as suppliers and assemblers of intermediate inputs within global production networks, while the second index provides a measure of the existence and depth of regional trade agreements. These indices form the basis of the analysis that assesses the symmetry between RTAs and GVCs.

The network trade index

The network trade index (NTI) between two countries, as proposed by Ferrarini (2011), is defined as a country B's share of total intermediate inputs imported by a processing industry in the reporting country A, weighted by that industry's share of total final goods exported by A, and summed across all industries. In other words, it gives an indication of how important a partner is for a given country in terms of imported intermediates required for the production and export of final products.[16]

The index is calculated for each pair of countries in both directions, e.g. from Mexico to the United States and from the United States to Mexico. To simplify comparisons, each of the country pair indices are averaged to obtain a single index for each given country pair. The index score can take values from 0, when there is no connection between the two countries, to 1 when all inputs used in the reporter's exports are sourced from that given partner. Network trade indices (NTIs) are calculated using OECD ICIO tables for 57 economies over the years 1995, 2000, 2005, 2008 and 2009.[17] Table 5 lists the top 15 country pairs ranked by decreasing averaged NTIs over the period 1995-2009, while Table C.4 in Annex C shows for OECD countries and key partners the indices with respect to their first five source countries in 2009, providing some insights on the bilateral relationships between the reporter and its partners.

15. WTO (2011), Orefice and Rocha (2013).

16. Imported inputs used for exports are defined in the literature as vertical trade; see Hummels *et al.* (2001).

17. See Tables A.1 and A.2 in Annex A for the detailed list of countries and sectors.

Table 5. Network trade index, average by country-pair

1995			2000			2009		
Country-pairs		NTI-average	Country-pairs		NTI-average	Country-pairs		NTI-average
CAN	USA	0.42	CAN	USA	0.44	CAN	USA	0.35
MEX	USA	0.40	MEX	USA	0.44	MEX	USA	0.29
JPN	USA	0.28	JPN	USA	0.22	AUT	DEU	0.22
AUT	DEU	0.26	AUT	DEU	0.21	CHE	DEU	0.20
KOR	JPN	0.18	TWN	JPN	0.19	JPN	CHN	0.18
CHE	DEU	0.18	IRL	GBR	0.18	KOR	CHN	0.17
TWN	JPN	0.18	CZE	DEU	0.18	ARG	BRA	0.16
SVK	CZE	0.17	RUS	ROW	0.17	CZE	DEU	0.16
RUS	ROW	0.16	KOR	JPN	0.16	PRT	ESP	0.15
IRL	GBR	0.16	ARG	BRA	0.16	IRL	USA	0.15
BRN	SGP	0.16	BRA	USA	0.16	TWN	JPN	0.15
CHL	USA	0.16	ROU	ITA	0.15	JPN	USA	0.15
CZE	DEU	0.15	KOR	USA	0.15	TWN	CHN	0.14
AUS	USA	0.14	CHE	DEU	0.15	POL	DEU	0.14
ARG	BRA	0.14	NZL	AUS	0.15	HKG	CHN	0.14

Source: Author's calculations using the OECD ICIO model. Top 15 country pairs ranked by decreasing averaged NTIs. The order of the countries listed above is such that the country reported first is the country with the highest NTI of the country pair. For the definition of the country codes, see table A.1 in Annex A.

Table 5 shows that the highest values of NTIs over the entire period are observed within NAFTA, highlighting the high degree of vertical specialisation across these countries. The examination of NTIs also reveals differences across trade partners, partly reflecting size. For example, for both Canada and Mexico the United States is the strongest partner, with network trade indices of 0.57 and 0.50 in 2009 (Table A.6), indicating the importance of the United States as a source of intermediate imports, whilst for the United States, the importance of Canada and Mexico as a source of intermediates is lower (0.12 and 0.08, respectively), reflecting in part the importance of other countries, such as China and Japan, as sources of intermediates.

The analysis also reveals the growing importance of regional production hubs, characterised in large part by increasing interdependencies amongst Central and Eastern European countries and within Asia. Within Europe for example, Austria, Switzerland and the Czech Republic all intensified their trade relationship with Germany. The Slovak Republic and Hungary also developed very strong ties with Germany after they joined the European Union.

Similarly, East and South-East Asian economies are characterised by a tight web of network connections with each other, reflecting the fragmentation of production processes that distinguishes the region. In this respect, China's growing integration into the Asian value chains is somehow confirmed by the increasing number of Asian countries' NTIs with China in 2009 compared with 2000 in Table 5. Although not shown here, a similar trend is observed also for other Asian economies, and in particular for ASEAN countries' NTIs values with China which accelerated from 2005 onwards, mainly in 2008. It is noteworthy mentioning that

it is in these years that the agreement ASEAN economies signed with China entered into force, first for goods and later on for cross-border trade in services and investment.

At the same time, changes in the importance of some countries have meant a reduction in the importance of some other trade relationships, for example between Ireland and the United Kingdom, the Czech Republic and the Slovak Republic, and Romania and Italy, which became less relevant over time as each country began to specialise in different stages of the production process and in different activities. These links are even more evident from the indices reported in Table C.3 in Annex C, where Germany stands out as the main sourcing partner for almost all European countries.

The RTA index

To capture the existence and depth of RTAs, the case study follows a simple approach that assigns a value of zero when no regional trade agreement has entered into force between two countries, and additional values on the basis of the coverage of the RTA as described below in Table 6.

The index is derived from a database that collects information on RTAs from the WTO Regional Trade Agreement Information System (RTA-IS) and integrated, when necessary, with information from other sources. The database covers all RTAs in force until 2012 for the 57 economies analysed in this case study. Cross-border trade in services and investment are considered only when the RTA includes substantive provisions on market access and national treatment. Agreements that simply mention the promotion of investment and/or trade in services in their preamble are not considered sufficient to be classified as RTAs covering trade in services and investment. In the case of investment, disciplines on pre-establishment are the criteria for market access and national treatment (provisions on the protection of investment or non-discrimination in the post-establishment are not criteria).

Table 6. The RTA index

Possible cases	Index score
No RTA between two countries	0.00
RTA covering goods only	0.25
RTA covering goods and cross-border trade in services	0.50
RTA covering goods, cross-border trade in services and investment (goods or services only)	0.75
RTA covering goods, cross-border trade in services and investment (goods and services)	1.00

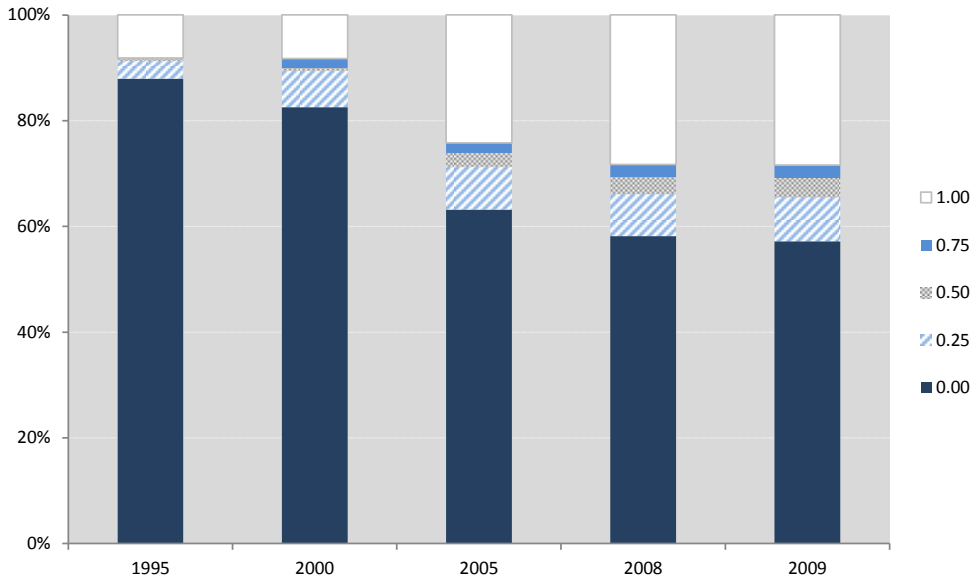
Participation in RTAs has increased considerably since the early 1990s, with many RTAs increasingly going beyond regional boundaries.[18] The number of RTAs signed since 1995 has increased considerably and the coverage of these agreements has been extended in many cases to include provisions on cross-border trade in services and investment in goods and services

18. Many of the RTAs currently in force are not strictly "regional" in the literal sense of the word as they often involve countries from different geographical areas. In practical terms, these agreements would be of the cross-regional type (WTO 2011).

(Figure 15). In 1995, only 8% of all RTAs considered for the 57 economies in the database included services and investment provisions but by 2009 the percentage of RTAs containing these provisions rose by 20 percentage points, illustrating how RTAs have evolved in recent years to go beyond tariff reduction measures.

This in part reflects the fact that, as tariff barriers have been progressively reduced over time – through subsequent rounds of multilateral, preferential agreements and unilateral tariff reductions – non-tariff barriers to trade have acquired a greater significance.

Figure 15. Evolution of the RTA index over time



Source: Author's calculations using the OECD ICIO model and the RTA database.

A number of recent studies provide empirical evidence to support this and have shown that preferential tariff rates are not the main reason why countries sign RTAs nowadays. A recent WTO report (WTO, 2011) estimated that half of global merchandise imports are duty free on an MFN basis. For the other half, a low utilisation of preferential tariff rates is reported. For example, Zhang and Shen (2011) indicate that less than 3% of intra-ASEAN trade benefits from preferential tariff treatment. They also find that importers prefer to apply MFN rates than undergo the administrative costs and delays involved in the application of preferential rates, particularly when the margins between the two rates are fairly small.

Clearly, RTAs that address trade liberalisation in services and the promotion of investment have become more significant in recent years as countries continue to attempt to reduce trade costs and boost growth, particularly given the recent reductions in tariffs more generally (despite the cumulative nature of tariffs in a world characterised by fragmented production).

GVCs and RTAs: Is there a match?

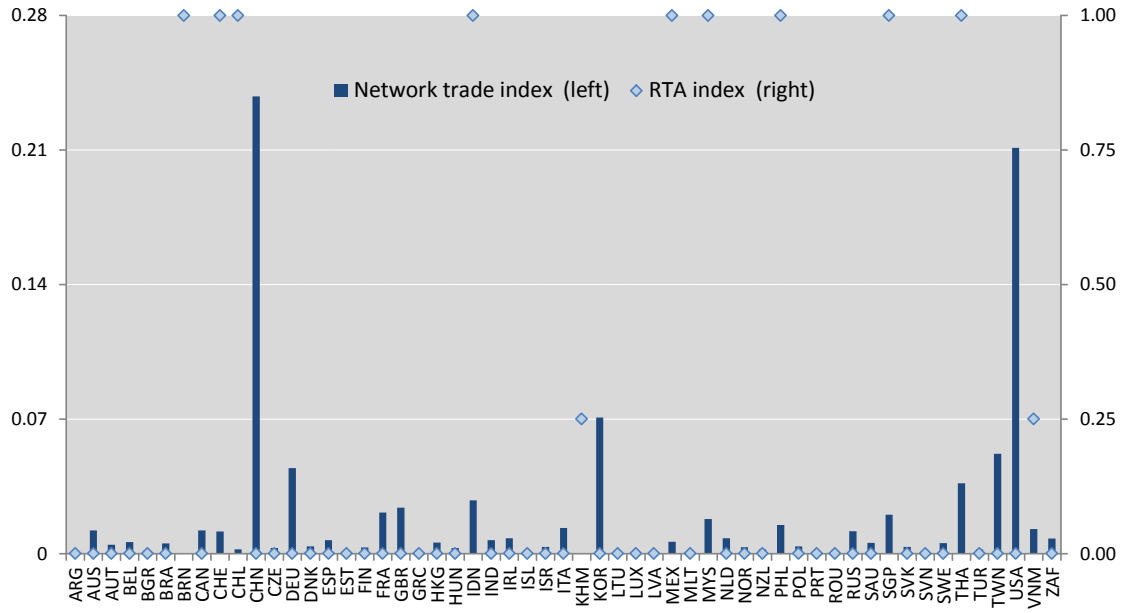
To assess the extent to which the "spaghetti bowl" of regional trade agreements matches global production networks, Table C.5 in Annex C presents a simple correlation coefficient between the network trade index and the RTA index for the 57 economies in the database. For each country and year, a correlation coefficient is calculated on the basis of all bilateral relationships with partners (whether inside or outside the region). A high value of the

correlation coefficient is expected when countries sign RTAs with their main network partners, i.e. those from which they source their intermediate inputs.

Table A.7 shows that the highest correlation coefficients exist for most European countries, some Asian economies, Canada, New Zealand and Mexico, reflecting how these countries benefit from RTAs signed with countries with which they trade the most. The results also illustrate that the correlation coefficients of some European countries accelerated after they joined the European Union. This is particularly the case for the Czech Republic, Hungary, Poland and Slovenia, whose correlation coefficients went from nearly zero to almost 1 from 2000 to 2005, reflecting the benefits of joining a free trade area involving partners like Germany, with whom they are very strongly connected.

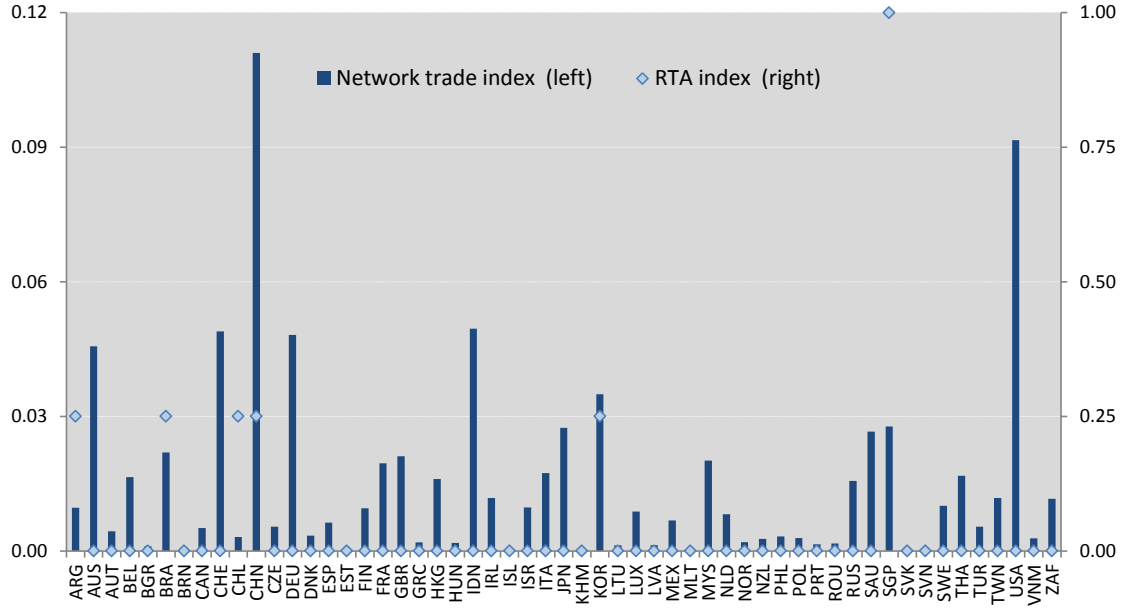
A different picture is observed for countries like Japan, India, China and Korea, characterised by rather low correlation values reflecting the limited number of RTAs they were involved in in 2009. Japan's first RTAs with Singapore and Mexico, for instance, entered into force not before 2005 and by 2009 Japan participated in only 11 RTAs, none of which were with its biggest trade partners such as China, Korea or the United States, as illustrated in Figure 16. The situation will look different in the future as negotiations are now engaged with most of these partners.

Figure 16. Network trade index and RTA index for Japan, 2009



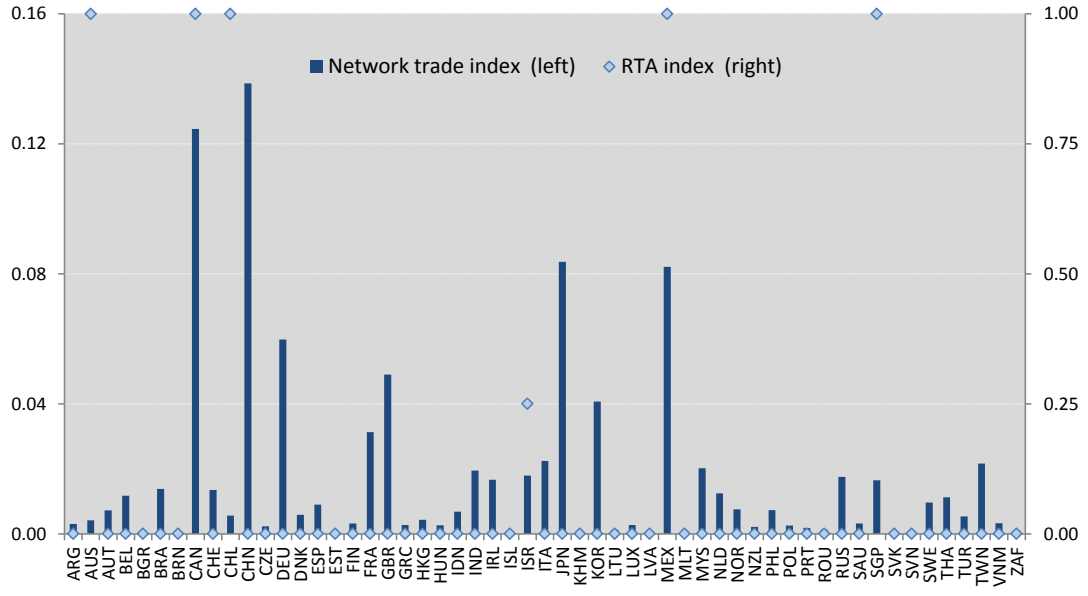
Source: Author's calculations using the OECD ICIO model and the RTA database.

Figure 17. Network trade index and RTA index for India, 2009



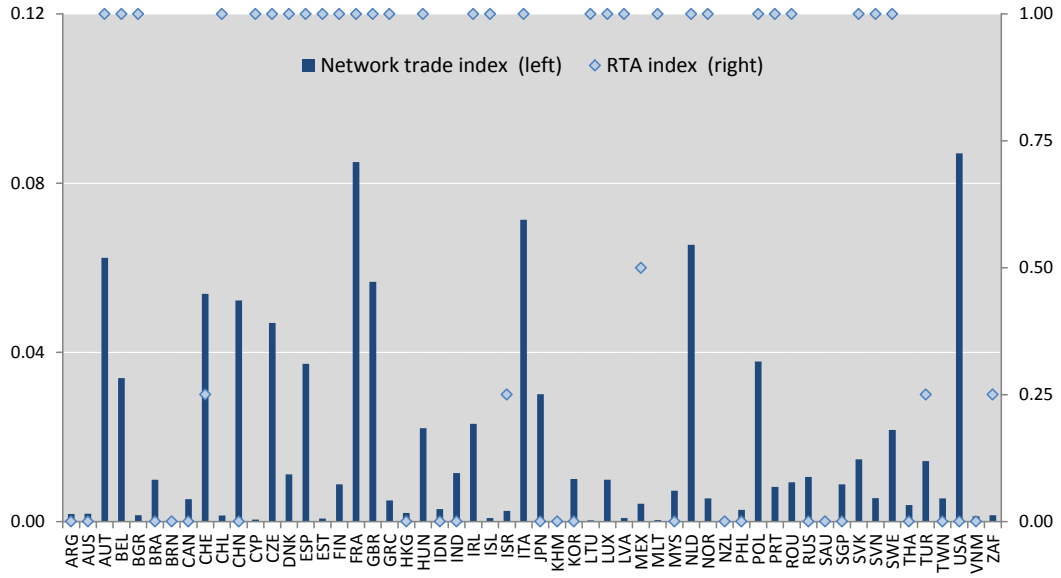
Source: Author's calculations using the OECD ICIO model and the RTA database.

Figure 18. Network trade index and RTA index for the United States, 2009



Source: Author's calculations using the OECD ICIO model and the RTA database.

Figure 19. Network trade index and RTA index for Germany, 2009



Source: Author's calculations using the OECD ICIO model and the RTA database.

Similarly, India started with only 2 RTAs in 2005 (with Singapore and Korea), but participated in just 6 RTAs in 2009.[19] A better match between trade and production networks would involve extending the coverage of those RTAs already signed (e.g. ASEAN-India or China-India), to include provisions on cross-border trade in services and on investment and engaging in new RTAs with other important partners such as the United States or Australia. The agreement with the European Union, still under negotiation, is likely to change the situation, in particular because Germany and Switzerland are important input suppliers for India (Figure 17).

Interesting is also the case of the United States (Figure 18), which despite having a coefficient of around 0.6 on average on the whole period considered, has potentially a higher correlation with the entry into force of the RTA with Korea and current negotiations with Japan (TPP) and the European Union (TTIP). Individual correlation coefficients are calculated for individual EU countries and the European Union as a single economy and illustrated in Table C.5 in Annex C, while Figure 19 describes the outcome for Germany as representative country of the European Union.[20] Focusing on extra-EU trade partners, with the exception of EFTA countries, there are not yet (as of 2009) significant extra-EU vertical trade relationships covered by a RTA, but as with the United States, the correlation coefficient is expected to

19. While the ASEAN-India agreement was signed in 2009, it has not entered into force at the same time for all parties involved. In the case of Indonesia for instance, and some other countries, it entered into force about one year later and therefore is not considered in this analysis, which stops in 2009.

20. Note that the Network trade index shown in Figure 19 is calculated with respect to Germany while the Regional trade agreements for non-EU countries reported in the figure are RTAs signed by the European Union as a whole.

significantly increase with agreements entered into force after 2009 (Korea) and under negotiation (EU-Japan, TTIP).

Conclusion

This case study has provided further evidence on the alignment between regional trade agreements and production networks. In the last year available in our data (2009), results differ across regions. In North America and in Europe, there are deep regional agreements that cover the main vertical intra-regional trade relationships. The absence of a transatlantic agreement is the main reason why correlation coefficients are not higher, together with the lack of connection to key Asian partners.

In the case of Asia, the outcome differs across countries. On the one hand, most ASEAN economies have RTAs with all their major GVC trade partners. On the other hand, the large economies of the region have correlation coefficients which are relatively low. This can be explained by the fact that these countries are late comers in regionalism and that RTAs with GVC partners were not yet in force in 2009 or are still under negotiation. There is currently no RTA involving China, Japan and Korea, while these three countries are at the core of Asian GVCs.

The big policy question of course remains: should countries try to match as far as possible production networks and negotiate RTAs with their main vertical trade partners? Due to the ever changing nature of GVCs, it may on the one hand appear as chasing an elusive goal with the risk of not being able to anticipate where trade opportunities will be. On the other hand, if the main partners in GVCs already represent a high share of vertical trade despite the absence of an RTA, one can wonder to what extent a trade agreement can bring additional gains. Trade and investment liberalisation also occurred through unilateral reforms, multilateral agreements or other kind of international arrangements such as bilateral investment treaties.

Yet, from an economic point of view, countries can still gain by reducing distortions across their main trade partners through RTAs. "Deep" provisions do appear to be more characteristic of RTAs than multilateral efforts so are more likely to address the specific needs of firms engaged in GVCs (Antràs and Staiger, 2012; Orefice and Rocha, 2013). That said, and having in mind the evidence on cumulative tariffs presented in the previous case studies and the interconnected nature of trade within GVCs, it would suggest that RTAs should cover as many countries and industries as possible to be supportive of as much as possible of the whole value chain. In the context of the deadlock in the Doha round negotiations at the WTO, this is undoubtedly why "mega-regional" agreements, such as the TPP or the TTIP have arisen.

More generally, GVC-friendly RTAs should have the following characteristics. They should be comprehensive and take into account complementarities between trade and other policy areas, such as investment, competition and the movement of people. The complementarity between goods and services also suggests that separate provisions on goods and services should be replaced by an integrated approach (National Board of Trade, 2012a). Rules of origin might have to be updated to account for the smaller domestic content in goods produced by domestic producers in the context of fragmented production processes.

Covering all significant partners in the value chain and dealing with all types of barriers affecting firms in a comprehensive way creates some kind of trade-off between the number of partners and how deep provisions can be. This is the challenge facing policymakers in current negotiations of "mega-regional" agreements.

Concluding remarks

This paper has illustrated with four case studies how taking GVCs into account has important implications for trade policy. In a world where production is vertically fragmented and trade in intermediate inputs is prevalent, trade policy does not radically change. Removing barriers to trade is still about achieving higher levels of income through deeper specialisation and scale economies. But one has to look differently at a certain number of issues. OECD (2013) provides an overview of the main implications for trade policymaking.

From the four case studies presented above, the following conclusions are reinforced:

- As an increasing share of the value of merchandise exports is made of services value-added (such as transport, distribution, finance, communication and business services), it makes sense for trade policy measures on goods and services to be dealt with together. New approaches will have to be sought in trade negotiations to avoid the silo approach where trade in goods and trade in services are treated in isolation.[21]
- Export competitiveness starts with efficient sourcing and removing barriers on imports. Enhanced access to foreign intermediate inputs reduces costs and encourages innovation. Preliminary analysis on the experience of Canada in removing tariffs on all intermediate and capital goods suggests that there are quite large productivity gains to be expected.
- While sectoral agreements, such as the WTO Information Technology Agreement, can be useful to reduce trade costs and boost trade and productivity in a given industry, a "GVC approach" in trade negotiations would have to go beyond industries. The value chain is a combination of different sectors that all participate in the same production process. Removing barriers all along the value chain involves trade liberalisation in a wide range of industries where, as previously emphasised, no distinction can be made between services and goods.
- The same way the full value chain is not covered when looking only at one industry, regional trade agreements fall short from covering all trade partners that matter in supply chain trade. Despite their proliferation and the increasing "spaghetti bowl" of agreements, some of the main vertical trade relationships in global trade are not yet covered by deep provision agreements, suggesting that the consolidation of RTAs in "mega" agreements or the revitalization of multilateral trade negotiations are needed to reap the full benefits of GVCs.

21. See Hoekman and Jackson (2013).

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Annex A

This Annex details the countries and sectors covered by the OECD Inter-Country Input-Output (ICIO) model used in the case studies.

Table A.1. List of countries

Code	Country	Code	Country
ARG	Argentina	KOR	Korea, Rep. of
AUS	Australia	LVA	Latvia
AUT	Austria	LTU	Lithuania
BEL	Belgium	LUX	Luxembourg
BRA	Brazil	MYS	Malaysia
BRN	Brunei Darussalam	MLT	Malta
BGR	Bulgaria	MEX	Mexico
KHM	Cambodia	NLD	Netherlands
CAN	Canada	NZL	New Zealand
CHL	Chile	NOR	Norway
CHN	China	PHL	Philippines
TWN	Chinese Taipei	POL	Poland
CZE	Czech Republic	PRT	Portugal
DNK	Denmark	ROU	Romania
EST	Estonia	RUS	Russian Federation
FIN	Finland	SAU	Saudi Arabia
FRA	France	SGP	Singapore
DEU	Germany	SVK	Slovak Republic
GRC	Greece	SVN	Slovenia
HKG	Hong Kong, China	ZAF	South Africa
HUN	Hungary	ESP	Spain
ISL	Iceland	SWE	Sweden
IND	India	CHE	Switzerland
IDN	Indonesia	THA	Thailand
IRL	Ireland	TUR	Turkey
ISR	Israel	GBR	United Kingdom
ITA	Italy	USA	United States
JPN	Japan	VNM	Viet Nam

Table A.2. Sector coverage

Nr.	Description	ISIC Rev.3
1	Agriculture, hunting, forestry and fishing	01T05
2	Mining and quarrying	10T14
3	Food products, beverages and tobacco	15T16
4	Textiles, textile products, leather and footwear	17T19
5	Wood and products of wood and cork	20
6	Pulp, paper, paper products, printing and publishing	21T22
7	Coke, refined petroleum products and nuclear fuel	23
8	Chemicals and chemical products	24
9	Rubber and plastics products	25
10	Other non-metallic mineral products	26
11	Basic metals	27
12	Fabricated metal products	28
13	Machinery and equipment, nec	29
14	Office, accounting and computing machinery	30
15	Electrical machinery and apparatus, nec	31
16	Radio, television and communication equipment	32
17	Medical, precision and optical instruments	33
18	Motor vehicles, trailers and semi-trailers	34
19	Other transport equipment	35
20	Manufacturing nec; recycling	36T37
21	Electricity, gas and water supply	40T41
22	Construction	45
23	Wholesale and retail trade; repairs	50T52
24	Hotels and restaurants	55
25	Transport and storage	60T63
26	Post and telecommunications	64
27	Financial intermediation	65T67
28	Real estate activities	70
29	Renting of machinery and equipment	71
30	Computer and related activities	72
31	Research and development	73
32	Other business activities	74
33	Public admin. and defence; compulsory social security	75
34	Education	80
35	Health and social work	85
36	Other community, social and personal services	90T93
37	Private households with employed persons	95

Source: OECD-ICIO model.

Annex B

Cumulative tariffs

The calculation of "cumulative tariffs" (CT) takes into account the full structure of tariffs added up at all stages a good's value chain and traces the total cost of all tariffs incurred along its production process. This Annex lays out the formula used for their calculation, following Rouzet and Miroudot (2013).

Let $t_{is,c}$ be the nominal tariff rate applied to imports of industry *i* from country *s* to country *c*, and $a_{is,jc}$ be the value of sector *i* output from country *s* used in the production of one currency unit of sector *j* output in country *c*. The $a_{is,jc}$ are elements of the matrix of technical coefficients *A*, which is derived from ICIO tables. Each row and each column of the *A* is a country-sector pair.

The cumulative tariffs embodied in an import of industry *i* from country *s* to country *c* has a chain of components corresponding to backward production linkages. First, the direct tariff $t^F_{is,c}$ is incurred at the last border crossing, where t^F stands for tariff on final goods. Second, industry *i* producers in country *s* have paid tariffs on their inputs from country *c* and third countries in proportion to their use of imported intermediate goods, which are given by the matrix of technical coefficients *A*. The sum of all second-stage tariffs is $\sum_{k,u} a_{ku,is} t^I_{ku,s} t_{ku,s}$ where subscripts *k* and *u* denote respectively the sectors and countries from which industry *i* producers in country *s* source inputs and t^I stands for tariff on intermediate goods. Each tariff is weighted by the share of the corresponding intermediate input in production, and domestically sourced inputs are assigned a zero tariff at this stage. Similarly, third-stage tariffs are given by $\sum_{k,u,l,v} a_{ku,is} a_{lv,ku} t^I_{lv,u} t_{lv,u}$. We can define in a similar way fourth-stage tariffs, fifth-stage tariffs, and so on. Then, adding up custom duties levied at all stages, we obtain the cumulative tariff which has been paid on an import along its production chain, and we can compare it with the nominal tariff it faces on the last border crossing to assess the extent of tariff magnification.

To simplify notation, let subscripts now denote a country-sector pair, so that a_{ij} is the intermediate use of country-sector *i* output in country-sector *j* production, and t_{ij} is the nominal tariff per unit of import from *i* to *j*. t^F_{ij} is an element of the final tariff matrix T^F, t^I_{ij} is an element of the intermediate tariff matrix T^I and *A*, T^F and T^I have dimensions *J x J*, where *J* is the number of country-sector observations. The cumulative tariff on an import from country-sector *i* to country-sector *j* is the *(i,j)* element of the *CT* matrix given by:

$$CT = T^F + \left[\sum_{n=0}^{\infty} \boldsymbol{e} \times B \times A^n\right]' \times \boldsymbol{e}$$

where $\boldsymbol{e}$ a $1 \times J$ vector of ones and $B \equiv A. \times T^I$ results from the element-by-element multiplication of *A* and T^I. For services sectors, direct tariffs $t^F_{i,j}$ are equal to zero, so cumulative tariffs are equal to the sum of indirect tariffs $[\sum_{n=0}^{\infty} \boldsymbol{e} \times B \times A^n]_i$.

According to a similar logic, the cumulative tariff on services value-added for on an import from country-sector *i* to country-sector *j* is the *(i,j)* element of the *CTS* matrix given by:

$$CTS = T^F.\times (S \times \boldsymbol{e}) + \left[\sum_{n=0}^{\infty} \boldsymbol{e} \times C \times A^n\right]' \times \boldsymbol{e}$$

where $C \equiv B.\times (S \times \boldsymbol{e})$, and S is a $J \times 1$ vector, each element s_i of which is the total services content of value-added in country-industry *i* which is derived from the Leontief inverse. The shares of tariffs paid on services value-added presented in Figures 2 and 3 are obtained as the ratio of CTS elements to the corresponding CT elements.

Indirect tariffs on services: Data sources

The OECD Inter-Country Input-Output model

Tracing trade barriers faced by a good along its production chain requires data on intermediate input linkages between countries and industries. The Inter-Country Input-Output (ICIO) model developed by the OECD provides estimates of bilateral transactions at the industry level. It is built from harmonised national input-output tables which are linked internationally with data on bilateral trade in goods by end-use category and bilateral trade in services. The methodology and assumptions underlying the construction of the OECD ICIO model are detailed in OECD-WTO (2012).

The resulting ICIO tables cover 57 economies and a "rest of the world" region, which account for over 95% of world output, and 36 industries. They provide information on intermediate input use by purchasing industry, supplying industry, destination country and source country, as well as on value-added and gross output, thus enabling us to track the stages and locations of production along a sector's value chain. The services sectors covered are sectors 22 to 37 in Table A.2. We use the data for 2000 and 2009. From global input-output tables, we derive the matrix *A* of technical coefficients. As explained above, an element of the matrix $a_{is,jc}$ is the value of sector *i* output from country *s* used as intermediate input in the production of 1 USD of sector *j* output in country *c*. Importantly, an underlying assumption of input-output models is that the structure of production is fixed following Leontief production functions.

Tariff rates by industry

Tariff data is drawn from the UNCTAD-TRAINS and Comtrade databases, which record tariffs and gross import flows by country of origin for over 170 countries. The TRAINS database provides information on *ad valorem* tariffs and *ad valorem* equivalents of specific tariffs at the disaggregated 6-digit level according to the Harmonized System (HS) nomenclature, by reporter and partner country. We use bilateral preferential rates when available. Although not exhaustive, the coverage of preferential tariffs in TRAINS includes GSP preferences, other preferential rates granted to developing countries, regional trade agreements and a number of bilateral agreements. If there are no preferential tariffs or if the information is not reported for a given reporter-partner-product, we use applied Most Favoured Nation tariffs. Like the input-output data, our tariff data cover 1995, 2000, 2005, 2008 and 2009.

Tariffs are then aggregated for each country pair from the 6-digit HS level to the industry detail of the OECD ICIO model, weighting each 6-digit product by its share of trade in the industry between the two countries as reported by the importer. For services imports, tariffs

are zero between all countries. Economies not covered individually in the OECD ICIO data are aggregated into a "Rest of the world" region in the same manner.[22] We obtain the matrix *T* of tariffs, where an element $t_{is,jc}$ is the tariff applied to direct imports of products from industry *i* in country *s* used by industry *j* in country *c*. Since tariffs on imported goods do not discriminate according to the industry of destination, $t_{is,jc} = t_{is,kc}$ for all *j*,*k*. The tariff matrix covers all country and sector pairs for the 58 economies and 36 industries in the OECD ICIO model.

Using the UN Broad Economic Categories (BEC) classification, as adapted for the OECD ICIO model, we split the tariff matrix into two components: tariffs on intermediate inputs and tariffs on final goods (corresponding to consumption and capital goods). The methodology follows Zhu, Yamano and Cimper (2011).

One caveat is that we do not take into account tariff exemptions granted in export processing zones and through inward and outward processing trade regimes and duty drawbacks. These regimes introduce a differential tariff treatment of imports depending on the sectors and the firms to which they are destined, as imported goods entering into the production of exports are not subject to import duties. The omission of such exemptions is, however, unlikely to bias the estimates in a significant manner for services sectors.

Effective rates of protection

Effective rates of protection assess the net impact of all trade policies affecting a sector. The ERP for an industry *j* has been traditionally calculated as:

$$ERP_{j,\mathrm{CAN}} = \frac{VA^{D}_{j,\mathrm{CAN}} - VA^{W}_{j,\mathrm{CAN}}}{VA^{W}_{j,\mathrm{CAN}}}$$

where VA^W is the value added by the industry at undistorted world prices, and VA^D is the value added corresponding to the highest price that can be charged by domestic firms to domestic consumers, taking into account tariffs on both output and inputs.

For instance, let us suppose that absent any tariff, a garment is produced with fabric worth 50 and sold at the world price of 100. Value added without protection is 50. A 30% nominal tariff on garments, which raises their price to 130, translates into a 60% effective protection rate, given that domestic value added accounts for only 50% of output value (and can be as high as 80 with the tariff). If there is no tariff on inputs, the ERP is always higher than the nominal tariff rate; all the more so as domestic activities represent a small share of value-added. If inputs are also subject to duties, however, the ERP is reduced and can even be negative. In our example, a 20% tariff on fabric (pushing its domestic price to 60) coupled with the 30% tariff on garments implies an ERP of 40%; and if there is no tariff on garments, the tariff on fabric alone results in a negative rate of effective protection for the domestic garment industry.

In a nutshell, the ERP is higher the larger the tariff on output, the lower the tariffs on intermediate inputs, and the smaller the industry share of value added at prevailing world

22. "Rest of the world" is based on data collected for 36 economies: Albania, Algeria, Bahrain, Bangladesh, Bolivia, Burkina Faso, Colombia, Costa Rica, Côte d'Ivoire, Dominican Republic, Ecuador, Former Yugoslav Republic of Macedonia, Guatemala, Honduras, Jamaica, Kazakhstan, Kenya, Madagascar, Mauritius, Nicaragua, Nigeria, Pakistan, Panama, Paraguay, Peru, Rwanda, Senegal, Sri Lanka, Tanzania, Togo, Tunisia, United Arab Emirates, Ukraine, Uruguay, Venezuela and Zambia.

prices. If nominal protection is the same on inputs and output, the ERP is equal to this common rate. However if tariffs are higher on final goods, as in tariff escalation, then the ERP exceeds the nominal duty rate.

Following Diakantoni and Escaith (2012), we can rewrite the ERP for sector *j* as:

$$ERP_{j,CAN} = \frac{t_{jW,\mathrm{CAN}} - \sum_{i,s} t_{is,\mathrm{CAN}} \cdot a_{is,j,CAN}}{1 - \sum_{i,s} a_{is,j,CAN}}$$

where $t_{is,CAN}$ is the nominal tariff rate applied to imports of industry *i* from country *s* to Canada, $t_{jW,,CAN}$ is the average nominal tariff on industry *j* output in Canada (*W* stands for "world" as trade partner and is constructed by averaging over import sources, where MFN or preferential tariff rates applied to each partner country is weighted by its share in Canadian imports in the sector), and $a_{is,j,CAN}$ is the value of sector *i* output from country *s* used in the production of one currency unit of sector *j* output in Canada. The tariff rates by industry, both bilateral and averaged, take into account not only applied MFN tariffs but also preferential treatments granted unilaterally or through preferential trade agreements The denominator is the share of sectoral value added, which includes the compensation of capital and labour used in production. The intermediate input shares $a_{is,j,CAN}$ are elements of the matrix of technical coefficients *A* derived from the global inter-country input-output table. Assuming Leontief production functions, the $a_{is,j,CAN}$ coefficients are exogenous.

Productivity estimations for Canada: Data and specifications

The data sources for the second part of the case study on the removal of input tariffs in Canada are the following. Import values by partner at the 6-digit HS level, from 1995 to 2009, are drawn from Comtrade. Applied tariff rates by partner at the 6-digit HS level for the same period come from TRAINS, and are aggregated by NAICS industries for the regressions of Table 4 using concordance tables from the US Bureau of Economic Analysis. The productivity data is drawn from Statistics Canada's productivity accounts (Table 383-0022), for 30 3-digit NAICS sectors covering agriculture, mining and manufacturing. The four measures of sector-level productivity are: multifactor productivity based on value added; multifactor productivity based on gross output; labour productivity based on value added per hour; labour productivity based on gross output per hour. The multifactor productivity data takes into account capital, labour, energy, materials and services inputs.

The estimations of Table 1 are obtained from fixed-effects regressions with bilateral imports (in logs) at the 6-digit HS level as the dependent variable according to the following specification:

$$\log(imports_{ist}) = \alpha_0 + \alpha_1 tariff_{ist} + \alpha_2 tariff_{ist} \cdot relief_s + \alpha_3 tariff_{ist} \cdot intermediate_s + \alpha_4 tariff_{ist} \cdot capital_s + \alpha_5 \log(gdp_{it}) + \delta_i + \gamma_t + \theta_{ind(s)} + \varepsilon_{ist}$$

In the above equation, $imports_{ist}$ is the value of Canada's imports of product *s* from country *i* in year *t*, gdp_{it} is the GDP of country *i* in year *t*, $tariff_{ist}$ is the applied tariff rate on Canada's imports of product *s* from country *i* in year *t*, and $relief_s$, $intermediate_s$ and $capital_s$ are dummy variables that take value 1 if product *s* is, respectively, covered by the tariff relief policy, an intermediate good or a capital good. The classification by end-use category is that of the TiVA database. δ_i, γ_t and $\theta_{ind(s)}$ are fixed effects for source countries, years and TiVA sectors. The last term is the error term, and standard errors are adjusted for clustering by sectors.

The coefficients of interest capture the sensitivity of imports to changes in tariff rates. For consumption goods, a 1 percentage point decline in tariffs on a product is associated with an increase in imports of $100 \times exp(\alpha_1 - 1)$ percent. For intermediate goods, the increase is $100 \times exp(\alpha_1 + \alpha_3 - 1)$ percent. For goods concerned by the tariff removal, the increase is $100 \times exp(\alpha_1 + \alpha_2 - 1)$. These values are reported in the bottom panel of Table 1 (implied coefficients).

The estimations of Table 2 are obtained from fixed-effects regressions with industry-level productivity as the dependent variable, measured in several ways, according to the following specification:

$$productivity_{kt} = \beta_0 + \beta_1 tariff_{kt} + \beta_2 tariff_{kt} \cdot intermediate\_sh_{kt} + \beta_3 tariff_{kt} \cdot capital\_sh_{kt} + \beta_4 intermediate\_sh_{kt} + \beta_5 capital\_sh_{kt} + \gamma_t + \theta_k + \varepsilon_{kt}$$

In the above equation, $productivity_{kt}$ is either multifactor productivity or labour productivity in industry k and year t, $tariff_{kt}$ is the average applied tariff rate on industry k's products across all trade partners, $intermediate\_sh_{kt}$ and $capital\_sh_{kt}$ are respectively the shares of intermediate goods and capital goods in industry k imports in year t, and γ_t and θ_k are time and industry fixed effects.

The Network Trade Index

The Network Trade Index (NTI), as designed by Ferrarini (2011), is calculated as the partner j's share (c_s^{ij}) in the reporter i's total imports of intermediate inputs ($\sum_j c_s^{ij}$), weighted by the share of the industry s in i's total final goods exported by the reporter i ($e_s^i / \sum_s e_s^i$).

$$NTI^{ij} = \sum_s \left(\frac{c_s^{ij}}{\sum_j c_s^{ij}} \right) \cdot \left(\frac{e_s^i}{\sum_s e_s^i} \right)$$

The NTI is calculated for the 57 economies of the OECD ICIO database, as listed in Table A.1, and the 37 sectors detailed in Table A.2. The indices are computed for the following years: 1995, 2000, 2005, 2008 and 2009.

Annex C

Table C.1. Indirect tariffs on services imports in selected economies, 2000

	AUS	BRA	CAN	CHN	EU	IDN	IND	JPN	KOR	MEX	RUS	USA
AUS	0.34%	0.35%	0.41%	0.42%	0.47%	0.44%	0.50%	0.49%	0.39%	0.39%	0.54%	0.56%
BRA	0.81%	0.57%	0.73%	0.72%	0.75%	0.75%	0.74%	0.74%	0.74%	0.44%	0.73%	1.10%
CAN	0.16%	0.21%	0.08%	0.13%	0.11%	0.19%	0.10%	0.10%	0.18%	0.10%	0.08%	0.09%
CHN	0.92%	0.93%	0.93%	1.06%	0.92%	0.93%	0.91%	0.89%	0.89%	0.89%	0.94%	0.69%
EU	0.10%	0.17%	0.06%	0.14%	0.08%	0.09%	0.09%	0.10%	0.16%	0.07%	0.12%	0.09%
IDN	0.47%	0.21%	0.29%	0.32%	0.36%	0.55%	0.32%	0.38%	0.31%	0.41%	0.33%	0.40%
IND	1.81%	2.06%	1.07%	1.93%	1.40%	1.70%	1.08%	1.33%	1.84%	1.39%	0.87%	1.40%
JPN	0.08%	0.07%	0.05%	0.13%	0.07%	0.10%	0.06%	0.08%	0.16%	0.07%	0.05%	0.07%
KOR	0.65%	0.59%	0.22%	0.54%	0.56%	0.64%	0.51%	0.42%	0.41%	0.52%	0.40%	0.62%
MEX	0.80%	0.70%	0.70%	0.78%	0.73%	0.90%	0.71%	0.71%	0.85%	0.85%	0.71%	0.87%
RUS	0.44%	0.22%	0.21%	0.48%	0.34%	0.46%	0.31%	0.33%	0.44%	0.28%	0.43%	0.44%
USA	0.07%	0.05%	0.04%	0.07%	0.06%	0.09%	0.06%	0.06%	0.07%	0.07%	0.06%	0.10%
ROW	0.50%	0.62%	0.19%	0.38%	0.39%	0.77%	0.25%	0.45%	0.60%	0.33%	0.47%	0.39%

Source: Author's calculations based on the OECD ICIO model and TRAINS. Columns are destination countries or regions, and rows are direct source countries or regions. The EU region comprises the 27 EU economies.

Table C.2. Indirect tariffs on services imports in selected economies, 2009

	AUS	BRA	CAN	CHN	EU	IDN	IND	JPN	KOR	MEX	RUS	USA
AUS	0.14%	0.10%	0.14%	0.15%	0.16%	0.14%	0.16%	0.17%	0.14%	0.16%	0.13%	0.12%
BRA	0.19%	0.16%	0.19%	0.27%	0.18%	0.06%	0.18%	0.17%	0.16%	0.17%	0.30%	0.19%
CAN	0.08%	0.10%	0.07%	0.08%	0.07%	0.04%	0.13%	0.10%	0.14%	0.08%	0.07%	0.04%
CHN	0.27%	0.22%	0.26%	0.36%	0.27%	0.24%	0.24%	0.22%	0.34%	0.19%	0.21%	0.31%
EU	0.06%	0.05%	0.06%	0.07%	0.04%	0.05%	0.05%	0.05%	0.06%	0.03%	0.05%	0.04%
IDN	0.25%	0.19%	0.25%	0.28%	0.25%	0.28%	0.25%	0.21%	0.23%	0.21%	0.24%	0.26%
IND	1.38%	1.96%	2.06%	0.70%	1.02%	0.77%	0.49%	1.31%	2.14%	0.44%	0.46%	0.31%
JPN	0.05%	0.05%	0.08%	0.06%	0.05%	0.05%	0.05%	0.06%	0.16%	0.06%	0.04%	0.04%
KOR	0.82%	1.68%	2.64%	0.84%	0.80%	0.94%	0.71%	0.62%	0.90%	1.78%	0.29%	0.33%
MEX	0.07%	0.08%	0.07%	0.06%	0.08%	0.07%	0.08%	0.08%	0.06%	0.08%	0.08%	0.06%
RUS	0.21%	0.13%	0.17%	0.27%	0.16%	0.16%	0.14%	0.14%	0.21%	0.17%	0.18%	0.22%
USA	0.04%	0.03%	0.03%	0.04%	0.03%	0.03%	0.03%	0.03%	0.03%	0.03%	0.03%	0.05%
ROW	0.24%	0.24%	0.34%	0.39%	0.24%	0.23%	0.19%	0.25%	0.43%	0.32%	0.22%	0.15%

Source: Author's calculations using the OECD ICIO model and TRAINS. Columns are destination countries or regions, and rows are direct source countries or regions. The EU region comprises the 27 EU economies.

Table C.3. Products with the highest weighted tariffs in the IT value chain, by tier of suppliers (2009)

Industry	Tier 1 imports	Tier 2 imports	Tier 3 imports	Tier 4 imports and beyond
Machinery and equipment n.e.c	Taps, cocks, valves & similar appliances	Petroleum oils	Petroleum oils	Petroleum oils
	Parts of gas turbines	Gold in unwrought forms	Flat-rolled products of iron/non-alloy steel	Flat-rolled products of iron/non-alloy steel
	Gold in unwrought forms	Bars & rods	Bars & rods	Bars & rods
	Parts of machinery	Flat-rolled products of iron/non-alloy steel	Photosensitive semiconductor devices	Salt & pure sodium chloride
	Semi-finished products of iron/non-alloy steel	Taps, cocks, valves & similar appliances	Gold in unwrought forms	Other casing and tubing
	Cathodes & sections of cathodes	Articles of iron/steel	Parts & accessories of machinery	Parts of motor vehicles
Office and computing machinery	Parts of data processing machines	Parts of transmission apparatus	Parts of transmission apparatus	Petroleum oils
	Parts of transmission apparatus	Parts of data processing machines	Petroleum oils	Parts of transmission apparatus
	Parts of office machines	Parts of office machines	Gold in unwrought forms	Other casing and tubing
	Gold in unwrought forms	Gold in unwrought forms	Parts of office machines	Other parts for motor vehicles
	Cathodes & sections of cathodes	Iron ores & concentrates	Parts of seats	Parts of seats
	Taps, cocks, valves & similar appliances	Petroleum oils	Parts of data processing machines	Light petroleum oils
Electrical machinery	Photosensitive semiconductor devices	Photosensitive semiconductor devices	Petroleum oils	Petroleum oils
	Parts of data processing machines	Parts of data processing machines	Photosensitive semiconductor devices	Photosensitive semiconductor devices
	Line pipes	Petroleum oils	Flat-rolled products of iron/non-alloy steel	Flat-rolled products of iron/non-alloy steel
	Boards, panels, consoles and other bases	Flat-rolled products of iron/non-alloy steel	Parts of data processing machines	Salt & pure sodium chloride
	Flat-rolled products of iron/non-alloy steel	Line pipes	Line pipes	Line pipes
	Parts of electric motors and generators	Other casing and tubing	Other casing and tubing	Bars & rods
TV and communication equipment	Photosensitive semiconductor devices	Parts of data processing machines	Photosensitive semiconductor devices	Photosensitive semiconductor devices
	Parts of data processing machines	Parts of transmission apparatus	Petroleum oils	Petroleum oils
	Parts of transmission apparatus	Aerials & aerial reflectors of all kinds	Parts of data processing machines	Flat-rolled products of iron/non-alloy steel
	Aerials & aerial reflectors of all kinds	Petroleum oils	Parts of transmission apparatus	Parts of data processing machines
	Parts of office machines	Parts of telephone sets	Aerials & aerial reflectors of all kinds	Parts of transmission apparatus
	Parts of telephone sets	Cathode-ray television picture tubes	Other casing and tubing	Other casing and tubing
Precision and optical instruments	Optical fibres & cables	Petroleum oils	Petroleum oils	Petroleum oils
	Objective lenses	Flat-rolled products of iron/non-alloy steel	Flat-rolled products of iron/non-alloy steel	Flat-rolled products of iron/non-alloy steel
	Parts of seats	Parts of seats	Bars & rods	Salt & pure sodium chloride
	Articles of vulcanised rubber	Articles of vulcanised rubber	Photosensitive semiconductor devices	Photosensitive semiconductor devices
	Lenses, prisms & mirrors	Photosensitive semiconductor devices	Salt & pure sodium chloride	Bars & rods
	Spectacle lenses	Bars & rods	Other casing and tubing	Parts of motor vehicles

Source: Author's calculations using the OECD ICIO model and TRAINS. For each tier of suppliers, tariffs are weighted by the contribution of the industry to output (information from the input-output matrix) and within the industry by the share of imports (COMTRADE). Values are averaged across countries to identify the top six products in each industry and tier. Products are described at the 6-digit level using the HS 2007 classification with some adjustments in the names to make the information easier to read in the table. Only products relevant for IT industries are reported.

Table C.4. Network Trade Indices (NTIs) by source country, 2009

Reporter \ Source country	1		2		3		4		5	
Australia	USA	0.15	CHN	0.12	SGP	0.08	JPN	0.08	THA	0.05
Austria	DEU	0.39	ITA	0.07	CHE	0.06	USA	0.05	CHN	0.03
Belgium	DEU	0.16	FRA	0.13	NLD	0.11	USA	0.07	GBR	0.06
Canada	USA	0.57	CHN	0.05	ROW	0.04	GBR	0.04	JPN	0.04
Chile	USA	0.25	ARG	0.14	ROW	0.08	CHN	0.08	DEU	0.06
Czech Republic	DEU	0.27	CHN	0.09	POL	0.07	SVK	0.06	JPN	0.04
Denmark	DEU	0.19	SWE	0.11	USA	0.07	GBR	0.06	NLD	0.06
Estonia	RUS	0.11	DEU	0.10	ROW	0.09	FIN	0.08	SWE	0.07
Finland	DEU	0.18	USA	0.10	SWE	0.10	CHN	0.08	RUS	0.07
France	DEU	0.19	USA	0.12	ITA	0.09	ROW	0.06	ESP	0.06
Germany	USA	0.09	FRA	0.08	ITA	0.07	NLD	0.07	AUT	0.06
Greece	USA	0.10	DEU	0.08	ITA	0.08	ROW	0.07	RUS	0.05
Hungary	DEU	0.26	CHN	0.07	AUT	0.06	FRA	0.05	USA	0.05
Iceland	USA	0.16	HKG	0.12	DEU	0.11	FRA	0.07	SGP	0.07
Israel	USA	0.21	DEU	0.08	CHN	0.07	CHE	0.06	GBR	0.06
Ireland	USA	0.28	GBR	0.15	NLD	0.09	ROW	0.06	DEU	0.05
Italy	DEU	0.18	FRA	0.10	ROW	0.08	USA	0.06	CHN	0.06
Japan	CHN	0.24	USA	0.21	KOR	0.07	TWN	0.05	DEU	0.04
Korea	CHN	0.19	JPN	0.17	USA	0.17	DEU	0.06	ROW	0.04
Luxembourg	DEU	0.17	GBR	0.11	BEL	0.11	CHE	0.10	USA	0.09
Mexico	USA	0.50	CHN	0.14	KOR	0.06	JPN	0.06	DEU	0.05
Netherlands	DEU	0.19	USA	0.12	BEL	0.07	GBR	0.07	FRA	0.06
New Zealand	AUS	0.20	CHN	0.11	USA	0.11	DEU	0.06	JPN	0.06
Norway	SWE	0.16	DEU	0.11	USA	0.10	DNK	0.08	GBR	0.08
Poland	DEU	0.25	ITA	0.08	CHN	0.06	FRA	0.05	RUS	0.05
Portugal	ESP	0.26	DEU	0.14	FRA	0.09	ITA	0.07	NLD	0.07
Slovakia	DEU	0.20	CZE	0.12	KOR	0.11	FRA	0.06	ITA	0.05
Slovenia	DEU	0.15	ITA	0.15	ROW	0.11	FRA	0.08	AUT	0.07
Spain	DEU	0.15	FRA	0.14	ITA	0.08	USA	0.07	ROW	0.06
Sweden	DEU	0.17	USA	0.09	NOR	0.07	GBR	0.07	DNK	0.06
Switzerland	DEU	0.34	ITA	0.10	USA	0.08	FRA	0.07	GBR	0.06
Turkey	RUS	0.12	ROW	0.11	DEU	0.10	CHN	0.07	FRA	0.07
United Kingdom	USA	0.16	DEU	0.15	FRA	0.07	NLD	0.05	ESP	0.05
United States	CHN	0.14	CAN	0.12	JPN	0.08	MEX	0.08	ROW	0.06
Brazil	USA	0.18	ARG	0.09	CHN	0.09	ROW	0.08	DEU	0.07
China	KOR	0.14	JPN	0.13	TWN	0.11	USA	0.10	ROW	0.05
India	ROW	0.16	CHN	0.11	USA	0.09	IDN	0.05	CHE	0.05
Indonesia	CHN	0.14	SGP	0.14	JPN	0.10	USA	0.09	KOR	0.07
Russian Federation	ROW	0.16	DEU	0.14	KOR	0.06	USA	0.06	CHN	0.05
South Africa	ROW	0.16	DEU	0.10	USA	0.09	SAU	0.07	CHN	0.07

Source: Author's calculations using the OECD ICIO model.

Table C.5. Correlation coefficient between the network trade index and the RTA index

Country	1995	2000	2005	2008	2009
Australia	0.07	0.07	0.76	0.75	0.72
Austria	0.99	0.96	0.99	0.99	0.98
Belgium	0.96	0.95	0.96	0.95	0.94
Canada	1.00	1.00	1.00	0.99	0.99
Chile	0.00	0.08	0.68	0.86	0.85
Czech Republic	0.35	0.12	0.98	0.93	0.93
Denmark	0.97	0.93	0.94	0.93	0.94
Estonia	0.00	0.00	0.70	0.70	0.70
Finland	0.84	0.83	0.87	0.82	0.80
France	0.88	0.86	0.90	0.89	0.85
Germany	0.85	0.77	0.85	0.78	0.79
Greece	0.93	0.78	0.60	0.60	0.67
Hungary	0.01	0.00	0.93	0.94	0.93
Iceland	0.74	0.62	0.53	0.42	0.47
Ireland	0.76	0.83	0.61	0.59	0.50
Israel	0.65	0.97	0.95	0.94	0.93
Italy	0.91	0.92	0.94	0.91	0.91
Japan	0.00	0.00	0.01	0.06	0.05
Korea, Rep. of	0.00	0.00	0.00	0.61	0.51
Luxembourg	0.89	0.84	0.92	0.88	0.86
Mexico	1.00	1.00	0.99	0.97	0.96
Netherlands	0.92	0.80	0.85	0.86	0.84
New Zealand	0.68	0.74	0.77	0.78	0.81
Norway	0.82	0.82	0.90	0.92	0.89
Poland	0.03	0.06	0.97	0.94	0.94
Portugal	0.96	0.98	0.99	0.98	0.98
Slovakia	0.59	0.30	0.95	0.90	0.87
Slovenia	0.00	0.00	0.99	0.96	0.96
Spain	0.94	0.93	0.95	0.93	0.93
Sweden	0.95	0.93	0.96	0.95	0.91
Switzerland	0.98	0.93	0.98	0.98	0.95
Turkey	0.00	0.85	0.81	0.60	0.61
United Kingdom	0.76	0.70	0.77	0.74	0.71
United States	0.47	0.70	0.72	0.61	0.59
European Union	0.13	0.06	0.09	0.07	0.09
Argentina	0.00	0.00	0.84	0.78	0.75
Brazil	0.00	0.00	0.31	0.29	0.32
Brunei Darussalam	0.85	0.39	0.63	0.58	0.67
Bulgaria	0.00	0.04	0.17	0.78	0.85
Cambodia	0.00	0.20	0.30	0.59	0.69
China	0.00	0.00	0.09	0.41	0.44
Hong Kong, China	0.00	0.00	0.74	0.82	0.83
India	0.00	0.00	0.16	0.46	0.51
Indonesia	0.10	0.21	0.62	0.84	0.88
Latvia	0.00	0.00	0.82	0.83	0.80
Lithuania	0.00	0.00	0.79	0.52	0.65
Malaysia	0.31	0.43	0.53	0.72	0.72
Malta	0.00	0.00	0.76	0.71	0.70
Philippines	0.05	0.04	0.09	0.57	0.55
Romania	0.00	0.00	0.05	0.97	0.97
Singapore	0.43	0.47	0.92	0.95	0.95
South Africa	0.00	0.55	0.73	0.59	0.57
Thailand	0.13	0.16	0.34	0.89	0.88
Viet Nam	0.16	0.34	0.52	0.72	0.87

Source: Author's calculations using the OECD ICIO model and the RTA database.