

### III. Special topic

## Tariff accumulation, effective protection and export competitiveness in global production

Are tariffs an issue of the past, thanks to progress in multilateral or preferential trade liberalization? Many analysts are turning their interest to non-tariff measures (NTMs) or trade facilitation because nominal tariffs seem too low to make a difference, 5% being sometimes presented as the threshold below which a difference in nominal tariffs does not matter anymore. Today, most of North-North trade is subjected to duties lower than 5% while 80% of developing country exports to developed country markets is duty free. With South-South trade dominated by low tariff commodities, custom duties appear more as an addition to total trade costs rather than a barrier to trade, except for some specific product lines that still suffer from peak rates.<sup>1</sup>

But, with the surge of global manufacturing and the international fragmentation of global value chains that characterised what is called the "Third Industrial Revolution", the cumulative effect of nominal tariffs along the supply chain amplifies their impact. Today, trade in intermediate goods represents more than half the volume of (non-fuel) international transactions. Traditional trade since the 18<sup>th</sup> century dealt mainly in commodities and in final products; 21<sup>st</sup> century globalised economy is increasingly characterised by "trade in tasks", where firms in different countries specialise in performing specific functions of the supply chain and exchange intermediate goods at different stages of processing.

In such a segmented manufacturing pattern, transaction costs (border and behind the border costs of trade) are a crucial part of the competitiveness of firms and determine in part their ability to participate in production networks. Moreover, transaction costs affect not only the competitiveness of goods but also –and perhaps more importantly– of services sectors. One of the most important results of the measurement of trade in value-added terms, in our view, is to fully expose the dominant weight of services in determining the commercial value of today's international trade.<sup>2</sup>

Measuring the international trade flows associated with global manufacturing poses a challenge to the trade statisticians; the answers that the statistical community has put forwards in the recent past solve only part of the issue but provide a rich stock of information that pushes forward the frontier of trade and market quantitative analysis. Mapping trade along global value chains (GVCs), identifying the industries that create value-added, how much and where it will be eventually consumed are the new challenges facing trade statisticians (WTO, 2015). Ordinary concepts of country of origin or country of (final) destination do not fully apply anymore: if we look at the national origin of the value-added incorporated in the final product, we realize that significant shares of the value may come from countries other than the country of origin as described by customs records. Similarly, the domestic value added embodied in the exports of intermediate products may end being consumed as final goods in unsuspected countries.

One of the new statistical tools developed by trade statisticians links a series of harmonized national input-output tables with trade flows between industrial sectors (trade in intermediate goods and services) or between industries and final consumers (trade in final products). The history of this measure of international trade in value-added is recent: the first attempt at developing a world-wide model took place less than 10 years ago (Daudin et al. 2006) and was developed on a non-official dataset (GTAP). The first measures based on official data were produced by WTO and IDE-JETRO (2011) on the Asian-Pacific region; in 2012 the EU sponsored WIOD project launched the first truly global database, followed in early 2013 by the OECD-WTO TIVA database.

From a market-access analysis perspective, mapping inter-industrial trade flows when they criss-cross international borders allows for the measuring of the additional cost that importing firms will pay for these inputs and, more importantly perhaps when international competitiveness is concerned, estimating the overall impact of these tariffs on the price of the output. As we shall see, the measure of trade in value-added brings back to the forefront scene the calculation of effective protection rate, one of the major tools of trade and tariff analysis in the 1970s which had fallen in relative oblivion with the rise of computable general equilibrium models. Looking at effective protection and its implications for "costs" competitiveness has also the virtue of refocusing the attention of analysts on firms and industries as the main subjects or objects of international trade.

This renewed focus on the sectoral and micro-economic dimensions of international trade is fully aligned with the most recent trends in trade theories (WTO, 2015); it makes a relevant contribution of trade statisticians to evidence-based decision making. The present discussion should also be understood as a contribution to the wider debate on the role of tax policies on trade and investment competitiveness; this broader fiscal thematic has taken a renewed importance in trade analytics when countries are part of a currency area and cannot use exchange rate as a tool for equilibrating their sectoral accounts. Even if members of a currency area are also part of a custom union (as it is the case in the EU, for example) and

1. In developed economies, these are especially prominent in agriculture where 35 per cent of agriculture tariffs in 2015 were tariff peaks (UN, 2015); developing countries' MFN duties imposed on imports of agricultural and clothing products are, in average, above or close to peak rates (WTO, 2014).
2. The OECD-WTO TIVA database released first in 2013 revealed that about 45% of total cross-border international trade is imputable to services, more than double the traditional balance of payments score. The difference is due to the value of services that are embodied in manufacture goods and invisible to traditional trade statistics.

cannot independently change their tariff schedules, understanding their implications on export competitiveness sheds important lights on the micro-economic implications of custom duties.

## 1. Effective protection and the price of value-added<sup>3</sup>

The main analytical tool to measure the impact of tariffs on industrial production costs and gross margins is rate of effective protection (EPR). Effective protection is calculated as a weighted average of nominal tariffs, but in this case, the weights are given by the value of inter-industrial flows of intermediate and final products. Moreover, the measure usually applies to industries and not to products as in traditional tariff analysis.<sup>4</sup> Conceptually, it is the difference accruing to an industry between the rent on output price provided by nominal protection and the additional production costs due to the higher domestic price of inputs. For a given industry, EPR is obtained as the ratio of its value-added at domestic prices and the gross margin the firm could pretend at if it had to operate at international prices, in a situation of free trade and zero tariffs.

In practice, EPRs are calculated by deducting the additional production cost the producer had to pay because of the tariff charged on the importable inputs from the nominal protection received on one unit of output produced by an industry and sold on the domestic market (at a price higher than the free-trade market price because of the duty charged on competitive imports). The result is compared with the hypothetical value-added that would have resulted from the operation if no custom duties were levied. Because production costs are usually known only at aggregated sectoral level thanks to Supply-Use tables or Input-Output matrices, EPR are calculated at aggregated "industry" level. For each industrial sector "j", its EPR is the difference between the nominal protection enjoyed on the output minus the weighted average of tariff paid on the required inputs, divided by value-added at free-trade prices.

It is given by:

$$EPR_j = \frac{t_j - \sum_i (t_i a_{ij})}{1 - \sum_i a_{ij}} \quad [1]$$

With

- $a_{ij}$  : elements of the matrix A of technical coefficients in an input-output matrix. Input coefficients  $a_{ij}$  are calculated by dividing input values of goods and services used in each industry by the industry's corresponding total output, i.e.  $a_{ij} = z_{ij} / X_j$  where  $z_{ij}$  is a value of good/service  $i$  purchased for the production in industry  $j$ , and  $X_j$  is the total output of industry  $j$ . Thus, the coefficients represent the direct requirement of inputs for producing just one unit of output of industry  $j$ .
- $t_j$  : nominal tariff on sector "j",
- $t_i$  : nominal tariff on inputs purchased from sector "i". "i" can be equal to "j" when a firm purchases inputs from other firms of the same sector of activity. In an inter-country framework, "i" includes also the partner dimension [c] as inputs from sector "i" might be domestic or imported.

If the tariff schedule is flat (all tariff are equal), the rate of effective protection on the value added is equal to the nominal rate of protection. In the presence of tariff escalation, downstream industries producing final goods will benefit from a higher effective protection. Upstream industries producing inputs will have, on the contrary, a lower protection and possibly a negative one if the sum of duty taxes paid on the inputs is higher than the taxes collected on the output.

## 2. EPRs and export competitiveness

If domestic industries were able to export at the price they sell domestically (meaning that firms are price makers and demand is price inelastic), a positive effective protection would mean an increase in exported value-added. Yet, this is usually not the case, unless the exporting firm has global market power, not a usual situation for most firms, especially those located in developing countries. So, the most common situation is that the exporting firm is a price taker and will have to compete on the international market at the international prices. For the firm, the export price should be lower than the domestic one by the amount of nominal protection received.<sup>5</sup> When the firm exports, the value added it receives will be lower:<sup>6</sup>

$$(1 - \sum_i (t_i a_{ij})) < (1 - \sum_i a_{ij}) \quad [2]$$

Therefore, a high EPR, resulting for example from high nominal duties and steep tariff escalation, reduces protected sectors' incentive to export, as their rate of return on the domestic market is higher than what they can expect on the international one. It is a well-known result that high EPRs discourage benefiting firms from exporting their output; this anti-export bias becomes even more relevant when analysing trade policy from a "trade in value added" perspective (Diakantoni and Escaith, 2012). Similarly, an exporting firm will be in an inferior position vis à vis a foreign competitor operating in a free trade environment, as

3. This and other sections borrow from Diakantoni and Escaith (2014).

4. The calculation could also be applied to products if detailed supply-use tables are available; see (WTO 2015) for the renewed interest of trade statisticians in compiling extended supply-use tables.

5. Alternatively, the firm may decide to charge higher price but will face a lower demand, depending on the value of the price elasticity. We do not analyse this option, which belongs more to the economic analysis of EPRs, through partial or general equilibrium approaches.

6. Even in this case, the firm may still have an interest in exporting, especially when the size of the domestic market is small and production costs decrease with volumes (scale effect).

its value-added when selling at world price (left hand side of equation [2]) is lower than its free-trade competitor (right hand side). This is particularly critical in a GVC context, when foreign lead-firms base their “make or buy” decisions as well as the choice of offshore localization from tight cost arbitrage (Kohler, 2004).

The negative impact of high EPRs on second-tier domestic suppliers derives from the fact that tariff duties influence the domestic price of all inputs, including those domestically produced (goods, but, as we shall see in the next section, services too). Domestic suppliers of tradable goods will be able to raise their own prices up to the level of the international price plus the tariff duty, without running the risk of being displaced by imports.

One of the most striking results of the trade in value-added research programme has been to highlight the role of services in defining overall international competitiveness. Once the value of services embodied in the production of goods is taken into consideration, the share of commercial services in world trade in value-added duplicates its Balance of Payments value. Moreover, the cost and quality of GVC-related services, both embodied and imbedded, is a key component for defining the competitiveness of any given industry and its capacity for up-grading the value-chain (Low, 2013).

For the services providers who have to support a higher cost of tradable inputs but cannot benefit from tariff protection, EPRs are negative. More importantly, their situation in terms of international competitiveness, as described by the left-hand side of equation [2], deteriorates: unless they accept to operate at lower gross margins than their international competitors, they are not competitive on the international market and the exporting firms which make use of their services will suffer a cost-disadvantage equivalent to inefficiency spill-over.<sup>7</sup>

This aspect of inefficiency spill-over is also increasingly relevant when looking at GVCs from a “trade and development” perspective: a productive chain is as strong as its weakest part. A GVC approach to industrialization, policy-makers should design “smart industrial policies” that, at the difference of old-style vertical industrial policies, look at value creation by reducing inefficiencies. As observed by Cella and Pica (2001), sectoral inefficiencies measured through the inter-industry linkages in the OECD were largely due to inefficiencies imported from other sectors via intermediate input prices, rather than to internal factors. Overpriced inputs may be due to technical inefficiencies affecting the upstream industrial sectors or the effect of distorting trade policies. This is a clear indication that tariff policy has a clear bearing on competitiveness: generous effective protection through high tariffs results at best in domestic prices higher than what they could have been and, at worst, in prices much higher than international ones. Therefore, by increasing the relative price of non-tradables with respect to tradables, tariffs act here as a kind of over-valued real exchange rate.

Distinguishing between the costs of domestic (superscript “h”) and foreign inputs (superscript “f”), EPR can therefore be written as:

$$EPR_j = \frac{t_j - [\sum_i (t_i a_{ij}^f) + \sum_i (t_i a_{ij}^h)]}{1 - \sum_i a_{ij}} \quad [3]$$

With  $a_{ij}^f$  and  $a_{ij}^h$  the intermediate consumption “i” from, respectively, foreign and home country required to produce one unit of output “j”.

When duty draw-backs or tariff exemptions (as in EPZs) correct for this bias and allow domestic producers to purchase inputs at international prices, export-oriented firms still have a disincentive to purchase inputs internally as their second-tier domestic suppliers (represented by the sum  $[\sum_i (t_i a_{ij}^h)]$  in equation [3]) won't be able to benefit from the duty exemption. Thus, despite draw-backs, the first-tier domestic suppliers exporting their products to other participants of the international supply chain remain at a disadvantage compared to their free-trade competitors (right hand side of equation [4]) when they source some of their inputs from other local suppliers or outsource part of their tasks to them:<sup>8</sup>

$$(1 - [\sum_i a_{ij}^f + \sum_i (t_i a_{ij}^h)]) < (1 - \sum_i a_{ij}) \quad [4]$$

EPZs or duty draw-back schemes will compensate the exporting firm for the additional production costs caused by tariffs only when it uses imported inputs (in this case,  $\sum_i (t_i a_{ij}^h) = 0$  and inequality [4] becomes an identity as  $a_{ij}^f \equiv a_{ij}$ ;  $\forall i, j$ ).

But such strategy prices-out domestic suppliers when nominal tariffs are high. The national suppliers of these domestic firms, because they sell on their home market, will not be able to draw back the duties they had to pay on their own inputs. Even if they were able to do so, through a somewhat complicated administrative mechanism, domestic suppliers using non-imported inputs would still be put at a disadvantage because nominal protection raised the domestic price of all tradable products, be they actually imported or not.

While the anti-export bias [3] is a well-known result from a traditional trade in final goods perspective, our new corollary [4] is relevant only from the vertical specialization perspective typical of GVCs, where a “buy” decision arising from a “make or buy” assessment implies arbitrage between domestic and foreign suppliers.

7. Domestic firms are supposed to operate with similar production technologies than their competitors. Obviously, a domestic firm may remain competitive on the international market despite higher costs if it benefits from other advantages, be they natural (access to cheap resources such as land or energy) or resulting from an industrial policy (subsidies).

8. Unless home firms substitute high-tariff domestic inputs for lower ones (negative correlation between changes in  $t_i$  and  $a_{ij}^h$ ) but our 2012 paper shows that almost no substitution took place in East Asia.

In the 53 economies included in the TiVA database in its 2013 edition (Table 1) EPRs have been declining since the conclusion of the Uruguay Round in 1995 (Figure 1) with the exception of petroleum products where an increase of 50% was observed and Transport equipment, other than vehicle, where the EPR remained constant. Despite a reduction in nominal protection between 1995 and 2008, significant inter-sectoral differences remain. The highest 2008 nominal protection on good producing sectors<sup>9</sup>, in average of all countries covered by the *TiVA* database, is found in the food and beverage sector, followed by agriculture. Their effective protection rates are also high, especially for food and beverage.

At the difference of agriculture, the primary sector of mining and quarrying has almost zero nominal protection and a negative rate of effective protection (i.e., the additional cost paid on inputs is higher than the protection received on the outputs). The situation of manufactured products varies; automobiles are usually highly protected, office and computing equipment is the least protected of all sectors, suffering from a negative effective protection of -2%.

The distribution of EPRs is heavily skewed towards a few highly protected sectors: 6 of them stood above the average of 9.4% in 2008 while the large majority (14) was at or below this value. One sector (office equipment) suffers from a negative EPR of -2%, down from a positive 5.5% in 1995. Not surprisingly, the sectors with higher EPRs in 2008 were also those benefiting from the highest nominal protection (see Figure 2).

High EPRs lower the competitiveness of domestic suppliers by increasing the “country cost” in the same way as an overvalued exchange rate does. Countries willing to actively participate in global value chains should therefore pursue tariff policies aimed at: (i) lowering nominal tariffs, in order to reduce transaction costs below the tipping point at which vertical specialization is profitable, as mentioned in Yi (2003), and (ii) reducing tariff escalation and effective protection rates in order to reduce the anti-export bias of the tariff schedule and its inflationary impact on the “country costs”.

The new light shed by the impact of tariffs on global value chains motivated Canada to promote a duty-free treatment for all intermediate goods with the objective of “being the first G20 country to become a tariff-free zone for manufacturers”.<sup>10</sup> East Asian developing countries reviewed in Diakantoni and Escaith (2012) followed the expected policy of lowering EPRs. Not only did nominal protection drop, but the dispersion of duties - the main source of variance in EPRs - was also lower as can be observed from the steeper drop in the NP average than in the median. As a result, EPRs decreased in both agriculture and manufacture sectors.

For the developed countries that had already low tariffs in 1995, the reduction in the protection of domestic manufacture was less impressive in absolute value but still important in relative terms. On the contrary, nominal protection of agriculture remained stable or even increased when weighted by the value of trade flows. As the protection on industrial inputs purchased by farmers decreased, they benefited from higher EPRs.

**Table 1. Sample of 53 economies covered in the 2013 TiVA database**

Name	Name	Name	Name
Argentina	Finland	Latvia	Saudi Arabia
Australia	France	Lithuania	Singapore
Austria	Germany	Luxembourg	Slovak Rep.
Belgium	Greece	Malaysia	Slovenia
Brazil	Hong Kong, China	Mexico	South Africa
Bulgaria	Hungary	Netherlands	Spain
Canada	India	New Zealand	Sweden
Chile	Indonesia	Norway	Switzerland
China	Ireland	Philippines	Chinese Taipei
Cyprus	Israel	Poland	Thailand
Czech Rep.	Italy	Portugal	Turkey
Denmark	Japan	Romania	United Kingdom
Estonia	Korea. Rep.	Russian Federation	United States
			Vietnam

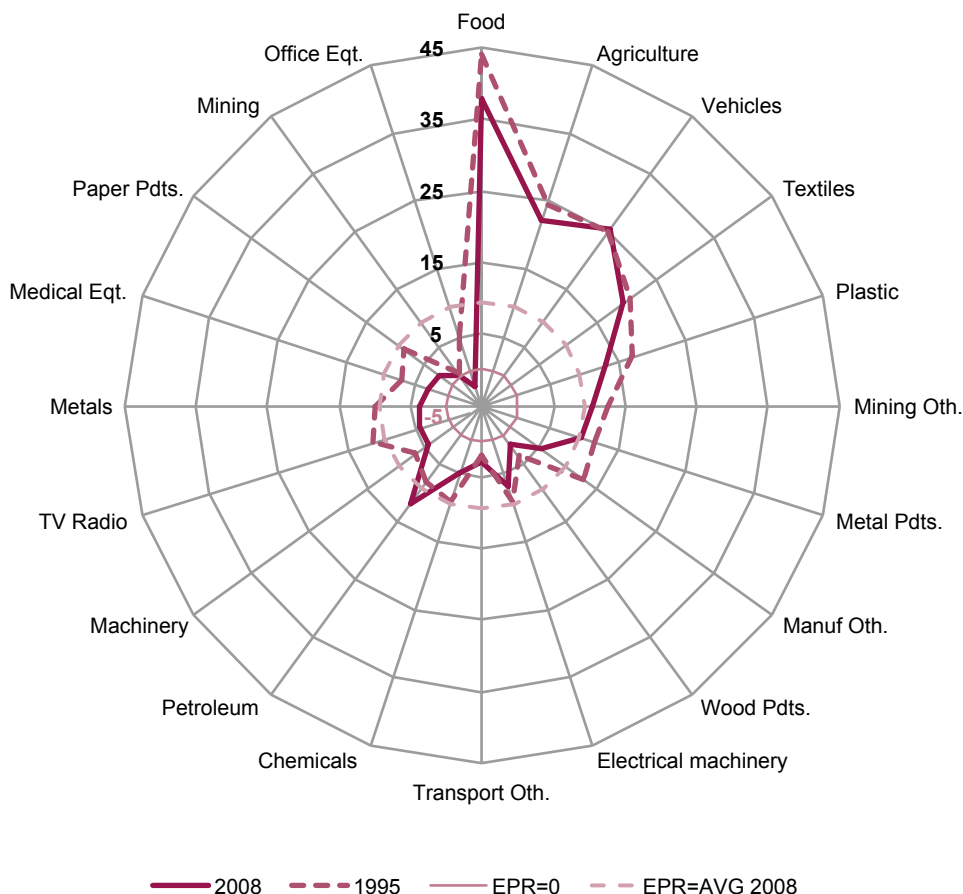
*Note:* The June 2015 TiVA release includes 62 economies. The new database was not available at the time of preparing the report.

9. Includes *ad valorem* equivalents.

10. Quoted from “*The Globe and Mail*”, 4 March 2010.

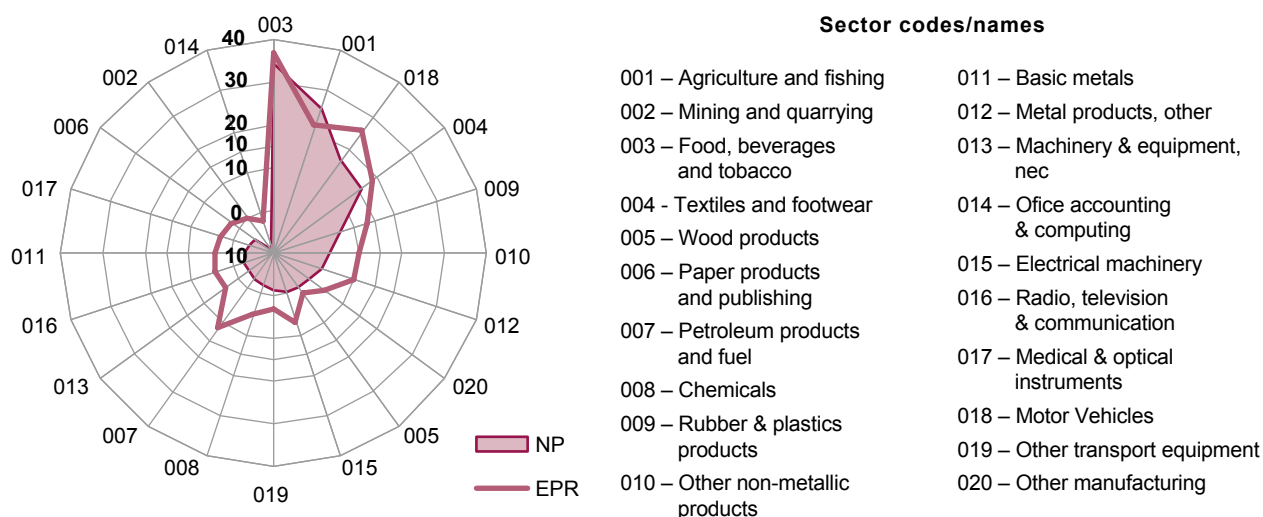


Figure 1. Effective protection rates by industry at MFN, 1995-2008



Note: Simple average of countries in Table 1.  
 Source: Based on Diakantoni and Escaith (2014)

Figure 2. Average nominal and effective protections, 2008



Note: Simple average of countries in Table 1, on the basis of MFN applied tariffs aggregated by industries.  
 Source: Diakantoni and Escaith (2014)

### 3. Impact of tariffs on domestic production cost

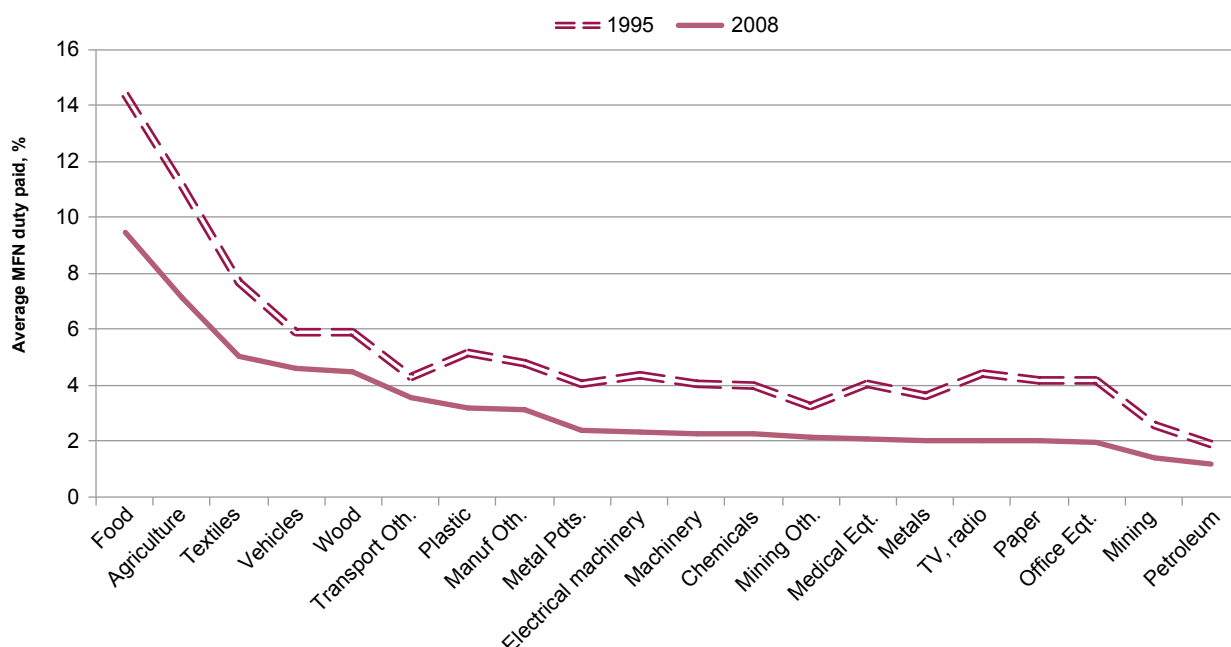
Not only the average MFN duties decreased between 1995 and 2008 on the sub-sample of countries covered by the TiVA database (from 5.7% to 4.7%) but also their dispersion. The 2008 line in Figure 3 is lower and smoother than the 1995 one, a visual intuition that is confirmed when looking at standard deviations across industries. (4.7 in 2008, down from 5.7 in 1995). Nevertheless, lower nominal tariffs in 2008 may have, in fine, a larger impact on the production cost of final goods when the production process is split between various countries, as is the case in GVCs. For the same reason, their impact on the cost of services, a key component of these supply chains, is getting increased attention.

While tariff analysis usually exclude services (trade in services is not dutiable), the availability of input-output data allows extending the analysis of the additional cost of production created by duties to the tertiary sectors. As mentioned, the role of services is crucial for understanding comparative advantages and competitiveness in trade in value-added. Effective protection on services is by definition negative when nominal protection on goods is positive. This may not be too much an inconvenience in the old trade policy approach, when services were considered as non-tradable. But in GVC trade, the higher production cost resulting from tariffs imposed on inputs used by the services industry may reduce the international competitiveness of exporting firms when the services-content imbedded in good production is high. This may lower the international competitiveness of the services industry when they are exporting directly. This will be, for example, the case of the tourist industry (hotels and restaurants) if the nominal protection on food and beverages is high. Figure 4 presents the results obtained for all sectors (goods and services) between 1995 and 2008, and the impact of preferences (lower duties than the MFN treatment, 2008 only). Preferential tariffs are applied to the bilateral flows of inputs that are fully identified in an international input-output matrix.

When analysing the graph, it is important to remember that a sector may purchase a large proportion of its inputs from suppliers that are classified in the same sector. Industries in the food and beverage sector, for example, will purchase raw agricultural inputs from agriculture and processed ones from other firms classified in the same food and beverage sector of activity. Because these two sectors benefit from high rates of nominal protection (Figure 2) the additional production cost will also be higher. The services sector of hotel-restaurants will also see its production cost impacted by the protection enjoyed by the providers of food and beverage.

The reduction of nominal tariffs that followed the conclusion of the Uruguay Round (1995) induced a significant reduction in the additional production costs attributable to the indirect MFN taxation on tradable inputs. The signature of preferential trade agreements has also reduced the production costs, in particular in the sectors of automobile and other transport equipment.

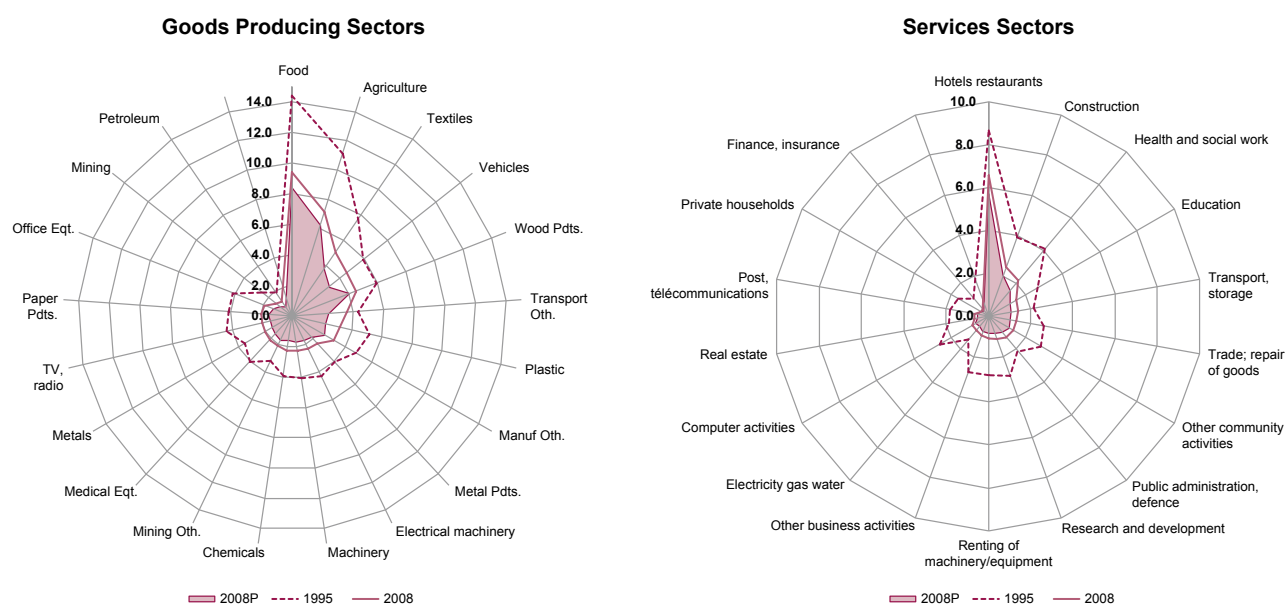
**Figure 3. Average MFN duties paid on intermediate inputs by industries, 1995-2008**



Note: Calculation based on the sub-sample of 53 countries mentioned in Table 1.

Source: Based on Diakantoni and Escaith (2014)

**Figure 4. Additional production cost due to nominal tariff duties (1995-2008) and effect of preferences (2008)**



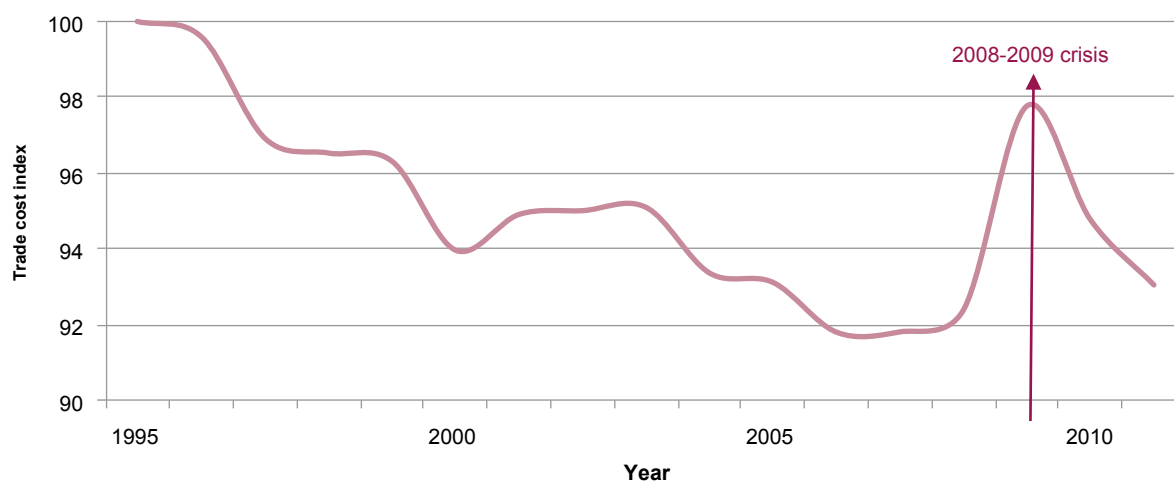
Note: The data refers to the total cost of duties perceived on the inputs required for the production of one unit of output.  
 Source: Authors' calculation.

#### 4. International trade and cascading transaction costs

Tariffs are not only affecting domestic production costs but are also a source of trans-border cost-push transmission. This is particularly the case when manufacturing is geographically segmented and trade in intermediate goods become important: the impact of tariffs and other additional transaction costs is amplified as intermediate goods are further processed by importing countries then re-exported. The cascading impact of these transaction costs (monetary and non-monetary, including the perception of risks) is sometime related to the slow-down in international trade which followed the 2008-2009 crisis.

For example, Escaith and Miroudot (2015) compare the important reduction in trade frictions in the 1990s and the more recent period (Figure 5). Trade frictions have increased before the financial crisis and an important peak is observed in 2008-2009

**Figure 5. World trade friction index, 1995-2011 (1995=100)**



Notes: Including goods and services; weighted average of bilateral trade frictions using trade partners' GDP.  
 Source: Escaith and Miroudot (2015) based on WIOD data.

with the “great trade collapse”. In 2011, the last year in their dataset, trade frictions are just back to their 2005 level. To explain this peak, it should be kept in mind that this trade frictions index reflects any type of transaction cost, including the reluctance of companies to trade in the middle of a financial crisis or the “home bias” (such as the trend observed among some consumers towards buying local products). It cannot be interpreted as a surge in protectionism. Nevertheless, it indicates that at the beginning of the 2000s and in the second half of the 2000s, the historical trend of decreasing resistance to trade has been interrupted, a key factor in explaining the slower growth of trade.

Yi (2003), Ma and Van Assche (2010) and Ferrantino (2012) highlight the non-linearity in the way in which transaction costs negatively affects trade-flows in a trade in task perspective, where goods have to travel through several nodes before reaching their final destination. The impact of tariffs and other additional transaction costs is amplified as intermediate goods are further processed by importing countries then re-exported; Yi (2003) indicates that a small decrease in tariffs can induce a tipping point at which vertical specialization (trade in tasks) kicks in, while it was previously non-existent. When tariffs decrease below this threshold, there is a large and non-linear increase in international trade. The cascading and non-linear impact of tariff duties when countries are vertically integrated can be extended to other components of the transaction cost. When supply chains require semi-finished goods crossing international borders more than once, the effect of a marginal variation in trade costs everywhere in the supply chain is much larger than would be the case if there were a single international transaction.

Ferrantino (2012) shows that, when trade costs apply in proportion to the value of a good, the total cost of delivering the product to the final consumer increases exponentially with the number of production stages.<sup>11</sup> For example, if the average ad valorem transaction cost is ten per cent, accumulated transaction costs in a five-stage supply chain lead to an ad valorem tariff equivalent of 34 per cent. Doubling the number of stages by slicing up the supply chain more than doubles the total delivery costs, as the tariff equivalent is 75 per cent. All this indicates the critical role of low transaction costs including tariff duties and non-tariff measures in facilitating trade in a “trade in tasks” perspective.

Rouzet and Miroudot (2013) formalize a measure of the cumulative tariffs embodied in trade in intermediates along international supply chains. In a GVC, imports of intermediate goods from industry “*i*” in country “*c*” has a chain of components corresponding to backward production linkages. First, the direct tariff “*t<sub>c</sub>*” is incurred when the imported good crosses the border between supplier country “*s*” and “*c*”. Second, suppliers in country “*s*” have also paid tariffs on their inputs from third countries in proportion to their use of imported intermediate goods. And so on and so forth. Using the matrix of technical coefficients *A*, the authors demonstrate that the cumulative tariff on an import from country-sector *i* to country-sector *j* is equal to:

$$CT_{ij} = t_{ij} + \sum_{n=0}^{\infty} t_i^{(n)} \quad [5]$$

where  $t_i^{(n)}$  (using the authors' notation) is the *i*-th element of the vector  $1 \times B \times A^n$  is a  $1 \times J$  vector of ones and  $B = A \otimes T$  results from the element-by-element multiplication of *A*, and *T* the associated matrix of nominal tariffs.

Their results reveal that although nominal tariffs are low in most OECD economies, indirect tariffs can add a significant burden by the time a good reaches its final user. For example, products imported from India into the EU pay an average total tariff of 3.7%, 51.5% of which being directly levied at the EU border and 48.5% resulting from duties on inputs imported by India at previous production stages. The cumulative effect of cascading tariffs explains why complex GVCs cannot develop when tariffs are above some threshold.<sup>12</sup>

The length of the international part of supply chains (the one being subject to cumulative tariffs) varies from country to country and sector to sector. Overall, the total number of production stages (i.e., involving the participation of several industries) calculated on TiVA database is relatively small (less than 2 when all good and services industries are covered) and 12% of them takes place in a foreign country. Yet the weight of the international share in the case of vertically specialised exporting firms may be much underestimated because traditional input-output tables aggregate both export-market and domestic-market oriented firms.

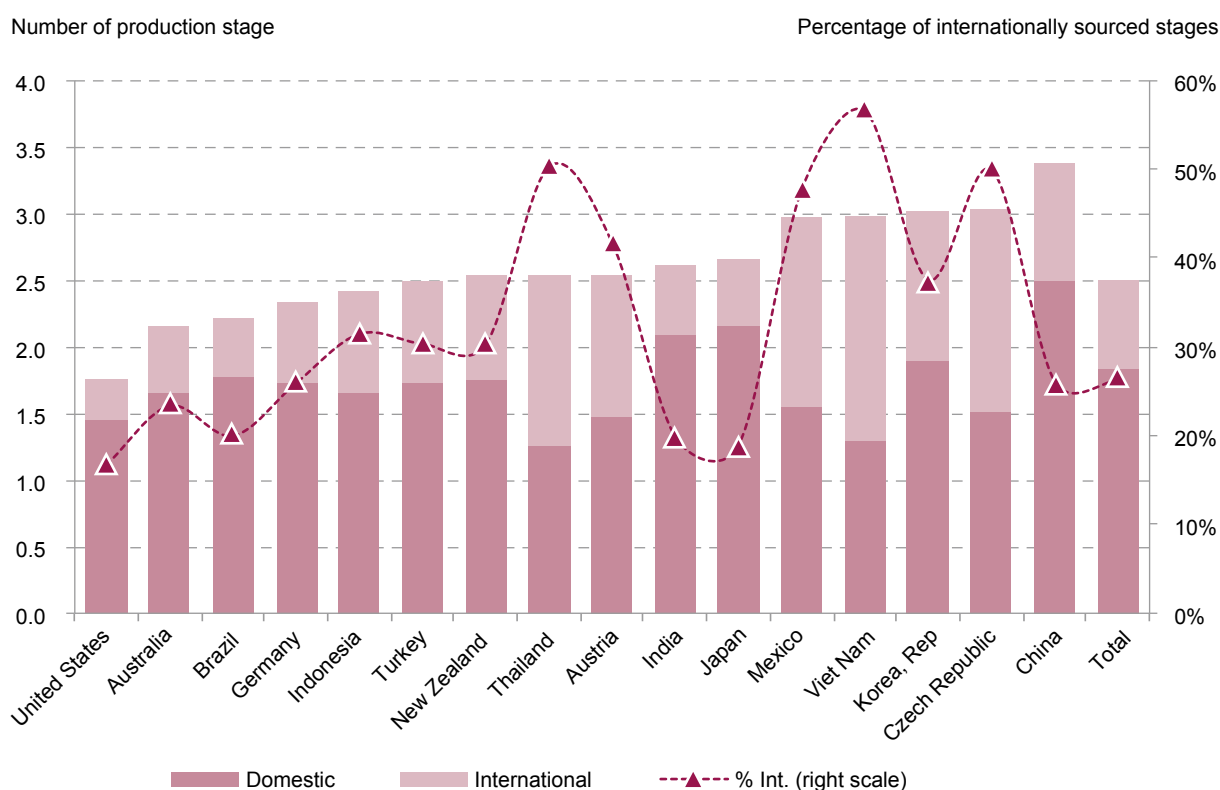
Structural factors other than sheer economic size are also determining: the smaller and service-oriented an economy, the larger is the relative weight of its international input procurements (Escaith and Gaudin, 2014). Let's take the example of “Electrical and optical equipment” (Figure 6), an emblematic sector of activity for international manufacturing. Despite all the debate on GVC-induced deindustrialization in the USA, the sector remains self-centred (less than 2 production stage, 17% being internationally sourced). The Czech Republic, Thailand and Vietnam, at the contrary, rely on international firms for 50% or more of the value chain; Mexico (48% of international segments) is also part of this group of internationally integrated producers that would be vulnerable to a rise of tariffs on their imported inputs or exported outputs.

11. More formally, the total cost of delivering the product to the final consumer after (*n*) production stage is:  $C(n) = \sum_{i=1}^n (1+t)^i$  where  $C(n)$  : total cost of delivering the product as a proportion of the production cost, *t* : ad valorem transaction cost at each stage, *N*: number of stages in the supply chain.

12. If inputs are perfectly substitutable (e.g., the referenced products identified by Rauch (1999), such as standards electronic components), it will result less costly for the importing firm to produce itself the required inputs or to source them from a third-country supplier which is itself fully integrated. In other words, GVCs collapse when the gains from specialization and economies of scale become lower than the duties collected along the supply chain.



**Figure 6. Number of production stages in electrical and optical equipment industry, 2008**



Source: OECD-WTO TiVA database: OECD Global Value Chains Indicators -May 2013.

## 5. Conclusions

In a GVC, firms trade in “tasks” rather than in final products; trading in tasks (or in value-added, using the statisticians’ vocabulary) highlights the role of tariffs on production costs and international competitiveness. With international trade fragmented and goods crossing national borders many times before reaching the final consumer, tariffs have an accumulative effect. Understanding this cascading effect and the implications on effective protection and competitiveness is particularly relevant when designing trade and industrial policies. Mitigating arrangements such as EPZs or draw-back schemes have only limited effects when GVC up-grading is the policy-makers’ main objective.

Services producers do pay the cost of customs duties when purchasing intermediates required for their functioning. Because they do not benefit from nominal protection, their EPRs are negative. More importantly from a trade in tasks perspective, their international competitiveness and the competitiveness of the firms they supply with their services are reduced.

Even if effective protection resulting from MFN tariffs decreased from 1995 to 2008, developing countries have a sizable number of highly protected sectors; some sectoral differentiation remains in industrialised countries or high income developing economies with relatively low natural resources endowment, with high protection in food industries and agriculture, in communication and computing equipment.

Joining an international supply chain offers new industrialisation opportunities for small developing countries. For example, Czech Republic, Thailand and Vietnam rely on international firms for 50% or more of their Electrical and optical equipment sector. The group of internationally integrated producers would be vulnerable to a rise of tariffs on their imported inputs or exported outputs.

Tariffs may have also a sizable effect on the production cost of services. The sector of hotels and restaurants experiences the highest indirect costs related to duties paid on inputs (almost 7% in 2008). This may negatively affects the competitiveness of the Tourism sector, one of the most dynamic export sectors of many small developing economies. Interestingly, regional or bilateral preferences have a low impact (-0.9%), a sign that preferences usually do not affect tariff peaks and leave highly protected sectors unscathed (WTO, 2011). Construction and Health services incorporate an additional average cost due to intermediates of 2.2-2.4%.

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