Trade in tasks, tariff policy and effective protection rates

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1 INTRODUCTION 2

2 TARIFFS, TRANSACTION COSTS AND EFFECTIVE PROTECTION: DEFINITIONS AND IMPLICATIONS 3

2.1 Tariff duties, effective rate of protection and tax on domestic value-added 3

2.2 Cascading transaction costs in production networks 5

2.3 EPRs and export-led development policy 7

2.4 EPRs, services and global value chains 9

2.5 EPRs, trade in value-added and the densification of domestic industrial network 9

2.6 Critics and new implications in a TiVA perspective 10

3 EVOLUTION OF NOMINAL AND EFFECTIVE PROTECTION SINCE THE URUGUAY ROUND 12

3.1 Calculating the Nominal and Effective Protection Rates 12

3.2 Evolution of the 1995-2008 MFN protection 13

3.3 Intermediate inputs and the impact of tariffs on the production cost 15

3.4 Nominal protection and the production cost of services 17

3.5 Overview of MFN and Preferences: from goods to services 20

4 UNDERLYING PATTERNS IN NOMINAL AND EFFECTIVE PROTECTION 22

4.1 Exploring the underlying economic patterns of MFN protection 22

4.2 The drivers of effective protection 24

5 CONCLUSIONS 29

BIBLIOGRAPHY 31

ANNEXES 32

Annex 1: Principal Component Analysis of Trade, Structural and *TiVA* variables 32

Annex 2: The Sectors 37

Annex 3: The Socio-economic variables 37

Annex 4: The MFN average protection (nominal and effective) by sector and year 38

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TRADE IN TASKS, TARIFF POLICY AND EFFECTIVE PROTECTION RATES

1 INTRODUCTION

Are tariffs an issue of the past, thanks to progress in multilateral or regional trade liberalization? Many analysts are now turning their interest to non-tariff measures because nominal tariffs seem too low to make a difference. Yet, with the surge of global manufacturing and the international fragmentation of global value chains, the cumulative effects of nominal tariffs along the supply chain amplify their impact while effective protection rates (EPRs) are back to the front scene when it comes to analysing trade in value-added. From this perspective, it is not goods or commercial services that countries and firms actually trade but "tasks". The remuneration of those tasks translates into the value-added that is aggregated and embodied at each stage of the global value chains by participating firms. Connectedness with other trade partners becomes a central feature for explaining bilateral trade from a network perspective: bilateral "trade in tasks" as economists call it, or "trade in value-added", using the denomination preferred by statisticians, [1] depends not only of comparative advantages between two countries, but also on their trade partners. The capacity for a firm to join an international supply chain depends of its relative location with both its upstream and downstream partners and its capacity to source inputs at competitive prices. More than in traditional trade, trade facilitation and transaction costs (border and behind the border cost of trade) are a crucial part of the competitiveness of firms and determine in part their ability to participate in production networks when lead-firms arbitrage costs.

Moreover, transaction costs affect not only the competitiveness of goods but also --and perhaps more importantly-- of sectors producing services. Why "*more importantly*"? Because one of the most important results of the measure of trade in value-added, in our views, is to fully expose the economic weight of services -- both "traded" and "non-traded" from a balance of payments perspective-- in today's international trade. The OECD-WTO *TiVA* database released in 2013 revealed that about 45% of the total value of cross-border international trade is imputable to services, more than double the balance of payments score. The difference is due to the value of services that are embodied in manufactured goods and invisible to traditional trade statistics.

As we shall see, if the domestic price of final goods is impacted by nominal protection, in the case of value-added, it is effective protection (the difference between the rent provided by nominal protection and the additional production costs due to the higher domestic price of inputs) which matters. For any industry, its EPR can be interpreted 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. Alternatively, the additional cost induced by traded intermediate goods on domestic services increases their domestic price, appreciating the real exchange rate as measured by the relative price of products on the home market with respect to the international ones. We only mention those aspects as one of the many possible uses of EPRs from a contemporaneous perspective, without entering more in details in their analysis: introducing changes in prices create some complex issues which are conceptually better treated outside the traditional input-output reference model. [2]

After reviewing the concepts and measures related to the theory and practice of EPRs, the paper will present the results obtained on a set of 53 economies covered by the OECD-WTO *TiVA* database. A third part will explore some of the relationship existing between nominal and effective tariff schedules and the export specialization of the countries. Technical annexes describe the construction of the various indicators used in the paper and present the details of the statistical data analysis that support the results. A conclusion summarizes the main results of the study.

[1] For statisticians, trade in tasks is measured through the value-added content of the goods and services that are exported. Value-added is calculated as the difference between the value of output (in basic prices) minus the sum of required intermediate inputs of goods and services. It is equivalent to the compensation for labour and for capital; it also includes a component for 'Other taxes on Production', net of subsidies.

[2] Mainstream economists recommend using partial/general equilibrium frameworks to model the proximate/ultimate effects of a change in relative prices. On the other hand, practitioners keep on using EPRs as one of their workhorses: EPRs are analytically adequate as long as they are used only as ex-post descriptive indicators (Diakantoni and Escaith, 2012).

2 TARIFFS, TRANSACTION COSTS AND EFFECTIVE PROTECTION: DEFINITIONS AND IMPLICATIONS

The following section reviews some of the implications of effective protection rates and cascading transaction costs in a global value chain perspective that motivated the present research. Cross-border transaction costs play a much larger role in this type of vertically integrated trade compared to traditional trade in final goods. Indeed, vertical specialisation leads to goods (or, at least, their various components at different stage of processing) crossing national borders several times before reaching the final consumer. As we shall see, implications go beyond a pure international trade perspective and touch also the field development economics and the debate on modern days "industrial policy".

2.1 Tariff duties, effective rate of protection and tax on domestic value-added

Among all cross-border transaction costs, nominal tariffs are certainly the most visible. Tariff duties increase the domestic price of tradable goods by adding a tax to their international or free market price. New implications appear when global value chains are prevalent. In a "trade in tasks" perspective, not only the value of nominal tariffs, but also their distribution between unprocessed and processed goods - a feature of nominal schedules known as tariff escalation – has a particular importance. By increasing more the domestic prices of processed goods relative to commodities, tariff escalation creates a significant anti-export bias on complex manufactured goods when value added is the traded "commodity", as is made clear when looking at the calculation of effective protection rates (EPRs).

EPRs focus on domestic prices and deduct from nominal protection the additional production cost the producer had to pay because of the tariff charged on the importable inputs. The result is compared with the hypothetical value-added that would have resulted from the operation if no custom duties were levied.

More formally, EPR for sector "j" 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:

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

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. A n-industrial sector economy is represented by a production structure defined by the input coefficient matrix **A** shown below:

$$\mathbf{A} = \begin{bmatrix} a_{11} & a_{12} & a_{13} & \cdots & a_{1n} \\ a_{21} & a_{22} & a_{23} & \cdots & a_{2n} \\ a_{31} & a_{32} & a_{33} & \cdots & a_{3n} \\ \vdots & \vdots & \vdots & \ddots & \vdots \\ a_{n1} & a_{n2} & a_{n3} & \cdots & a_{nn} \end{bmatrix}$$

- 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 effective protection on the value added is equal to the nominal 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.

Box 1: EPRs and trade in value-added

The basic relationship of trade in value added, from a single country perspective, can be described as follows:[3]

$X = \mathbf{A}X + Y$ [2a]

Often written (after rearranging terms): $X = [\mathbf{I}-\mathbf{A}]^{-1} Y$ [2b]

where:

X: is an n*1 vector of the output of n industries within an economy.

A: is an n*n technical coefficients matrix; where a_{ij} is the ratio of inputs from domestic industry *i* used in the output of industry *j*.

I: is the diagonal n*n identity matrix

Y: is an n*1 vector of final demand for domestically produced goods and services (final demand includes consumption, investment and exports) and **A***X* results in a vector of direct and indirect intermediate inputs required for producing *Y*.

A country's total value added can be split in two parts: one is the VA embodied in goods and services absorbed domestically (consumption and investment), the other is the VA embodied in its exports. Assuming the homogeneity of products made for the domestic market and products made for exports, total imports embodied directly and indirectly within exports are given by:

Import content of exports = $M(1-\mathbf{A})^{-1} E$, where:

M: is a 1*n vector with components m_j (the ratio of imports to output in industry *j*)

E: is a n*1 vector of exports by industry to the rest of the world.

In the same way, one can estimate the total indirect and direct contribution of exports to value-added by replacing the import vector *m* above with an equivalent vector that shows the ratio of value-added to output (*V*), with $V_j = [1 - \sum_i a_{ij}]$

So, the contribution of exports to total economy value-added is equal to:

VAE: $V(\text{I}-\mathbf{A})^{-1}E$ [3.a]

Discounting the reflected part of domestic value-added exports that return home embodied into imported intermediate goods, we can define two types of domestic VA exports: final and intermediate:

VAE(fd): $V(\text{I}-\mathbf{A})^{-1} E^{fd}$ [3.b]
VAE(imd): $V(\text{I}-\mathbf{A})^{-1} E^{imd}$ [3.c]
With $E^{fd}+E^{imd} = E$

In traditional trade in value-added analysis, **A** is constructed at prices that reflect the actual price structure of the economy (*P)*, including tariffs (but excluding indirect producer taxes and subsidies). Effective protection analysis differs by considering that $[1 - \sum_i a_{ij}]$ is the rate of sectoral value added per unit of output when there is no tariff and the domestic prices of tradable goods are similar to the international ones. P^* being international prices, $(p_j - p_j^*)/p_j^* = t_j$.

[3] OECD-WTO (2012), 'Trade in value-added: concepts, methodologies and challenges (joint OECD-WTO note)' WTO-MIWI.

EPR can be interpreted as the ratio of value added per unit of output at domestic prices -- tariffs applying on both output and inputs -- on the value added the industry would have gained if operating at international prices (without tariff duties). As mentioned by Balassa and Schydlowsky (1968) EPR "is designed to indicate the degree of protection of value-added at a given stage of the manufacturing process [and] equals the excess of the remuneration of domestic factors of production obtainable by reason of the imposition of tariffs and other trade barriers as a percentage of value-added in a free trade situation".

EPRs can be interpreted as the ratio of the value added obtained considering the given (applied) tariff schedules compared to a situation of free trade and no tariff (MFN-0).

$EPR_j = V_j / (V_j^*)$ [4]

where V_j and V_j^* are, respectively, the value added in industry "j" as measured at protection-inclusive domestic prices and undistorted world prices.

As highlighted in Escaith (2014b) the effect of tariff on value-added in [4] can be interpreted as a change of price related to an exogenous shock on the cost of primary factors (e.g., wages, profits or indirect taxes) due to tax policy. Modelling such a shock on the price of value-added may be complex because a portion of the cost-push effect is endogenous from a Leontief model perspective. The shock does not only change the price of exogenous "quantities" but also endogenous ones (i.e., tariffs duties are not like a VAT on consumers that affect only the price of final goods: the relative price of intermediate consumption is also affected). Moving to a monetary analytical framework has theoretical implications on the properties of the model (see for example Kuenne, 2008 or Mesnard, 2013). Escaith (2014b) states that the conceptual issue is not such a big one from a practitioner's perspective when the input-output framework is used only as an ex post accounting framework. In other terms, when all the values --be they parameters or results-- are observed magnitudes corresponding to an outcome that happened in the past. [4]

2.2 Cascading transaction costs in production networks

When trade is done along global value chains, trade in intermediate goods become essential. 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), Ma and Van Assche (2010) and Ferrantino (2012) highlight the non-linearity of the way in which transaction costs negatively affect trade-flows in a trade in task perspective, where goods have to travel through several nodes before reaching their final destination.

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 specialized 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 the good, the total cost of delivering it to the final consumer increases exponentially with the number of production stages. [5] 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

[4] As mentioned, similar critics have been addressed at the use of Effective Protection Rates for analytical and policy making purpose (see footnote 2).

[5] More formally, the total cost of delivering the product to the final consumer after (n) production stages is: $C(n) = \sum_{i=1}^{n} \frac{1}{n}(1+t)^i$ [6] 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.

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) amend Diakantoni and Escaith (2012) and 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" include themselves imports corresponding to backward production linkages. First, the direct tariff "t^c" 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 cumulative tariffs on imports from country-sector *i* to country-sector *j* are equal to:

$$\mathrm{CT}_{i,j} = t_{i,j} + \sum_{n=0}^{\infty} \tau_i^{(n)} \quad [5]$$

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

Their estimates reveal that although nominal tariffs are low in most OECD economies, indirect tariffs can add a significant burden by the time goods reaches final users. 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. Rouzet and Miroudot (2013) results provide important insights for clarifying the conclusions of Yi (2003): in actual business practices, the cascading effect of tariffs in a supply chain is bounded as long as intermediate goods produced by the supply chain are substitutable by products offered on the domestic or international market. The cumulative effect of cascading tariffs in [5] is bound; this explains why complex GVCs cannot develop when tariffs are above some threshold. [6]

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. Figure 1 shows results obtained using the OECD-WTO *TiVA* database for 2008. Overall, the total number of production stages (i.e., involving the participation of several industries) is relatively small (less than 2 when all good and services industries are covered) and 12% of them takes place in a foreign country. A word of caution is called for when interpreting the indicators: because input-output matrices developed for national accounts purpose aggregate in a single coefficient all firms, large and small, internationally integrated or dedicated only to their local market, the weight of the international share of the supply chain may be much underestimated in the case of vertically specialised global firms. Moreover, *TiVA* has a low level of industrial detail and the indicator suffers from an aggregation bias (the more aggregated are the sectors of activity, the smaller will be the number of different production stages).

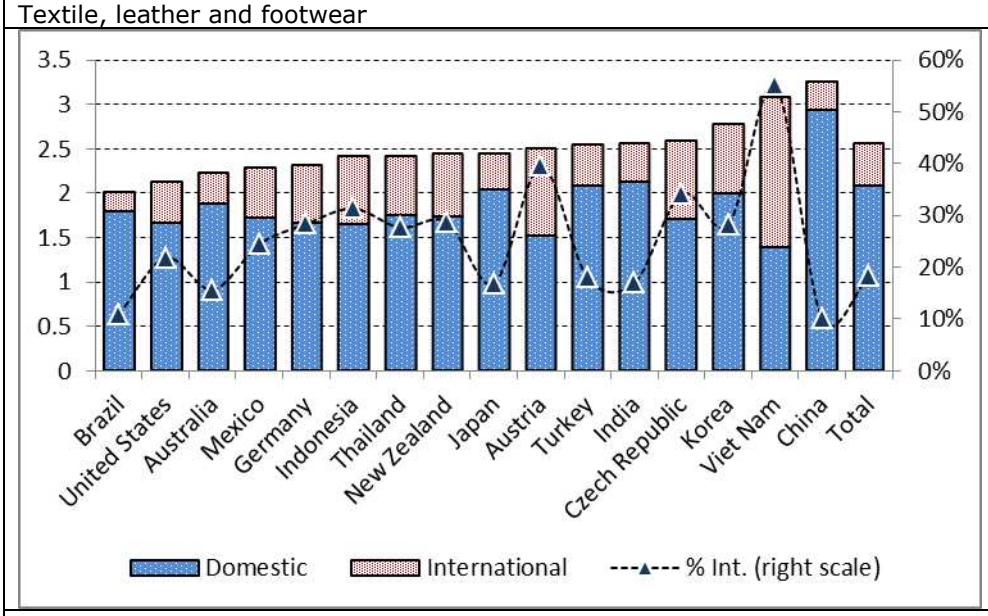
Structural factors are also determining: the smaller and service-oriented an economy, the larger is the share of its international input procurements (Escaith and Gaudin, 2014). Let's take the example of textile and footwear, the usual point of entry of lesser developed countries in global value chains (panel *a* of Figure 1). [7] Production involves normally between 2 and 3 different industrial sectors. While Brazilian firms are relatively concentrated and source their inputs from the domestic market (only 2 production stages, 11% being international), China and Vietnam have much longer supply chains, mainly domestic in China (90% of the stages) and principally international for Vietnam (55%). Therefore, this economy would be much more vulnerable to the cumulative effect of a rise in tariff duties affecting the international supply of inputs for its textile and footwear industries.

[6] 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.

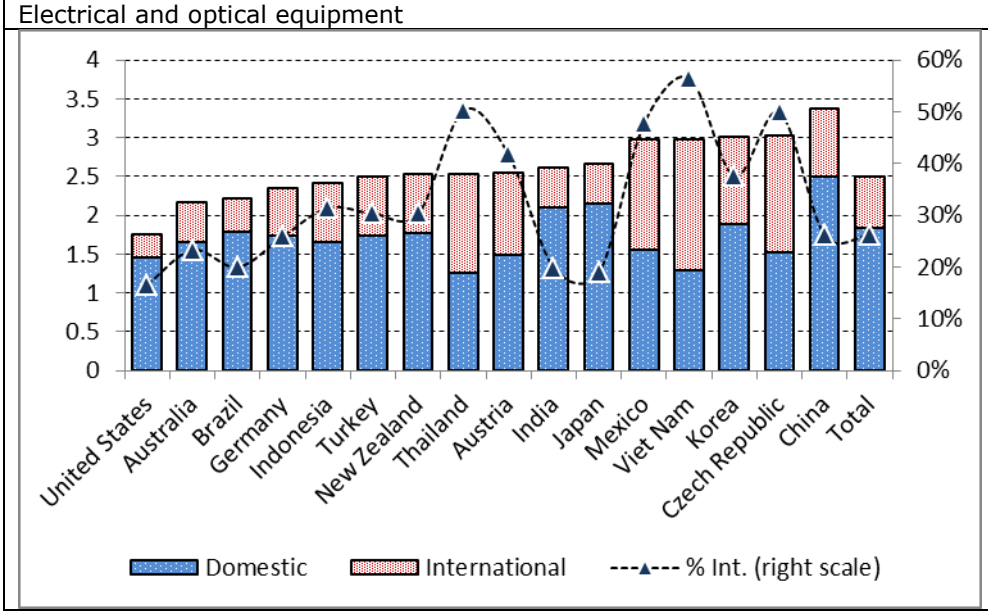
[7] See Annex 2 for a list of sectors and their ISIC Rev.3 composition.

Figure 1: Number of production stages, 2008

Textile, leather and footwear



Electrical and optical equipment



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

Electrical and optical equipment industries are also emblematic activiies for international manufacturing. Despite all the debate on GVC-induced deindustrialization in the USA, the sectorial average 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 close to this group of internationally integrated producers that would be vulnerable to a rise of tariffs on their imported inputs or exported outputs.

2.3 EPRs and export-led development policy

In theory, if domestic industries were able to export at the price they sell domestically (meaning that demand is price inelastic), a positive effective protection would mean an increase in exported value-added (see Box 1). Yet, this is usually not the case. When demand is price elastic, the exporting firm will have to compete on the international market at the international prices. Its

export prices should be lower than its domestic ones by the amount of nominal protection received. [8] But by doing so, the resulting value added will be lower:

$$\left(1-\sum_i\left(t_i\ .a_{ij}\right)\right)<\ \left(1-\sum_i a_{ij}\right) \qquad [7]$$

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. Similarly, an exporting firm will be in an inferior position vis à vis a foreign competitor operating in a free trade environment, as its value-added when selling at world price (left hand side of equation [7]) is lower than its free-trade competitor (right hand side). This is particularly critical in a GVC context, when the lead-firm's make or buy decision as well as the choice of offshore localization results from tight arbitraging (Kohler, 2004).

Box 2: Effective Protection and Preferences

Rouzet and Miroudot (2013) rewrite the ERP for exporters, taking into consideration the tariff faced by their products in the importing country. In this case, nominal protection on output enjoyed by local producers becomes an implicit tax on value-added for the exporter (even if the tax duties are paid by the importer, the exporter had to reduce its selling price and profit margins in order to remain competitive). The authors distinguish effective protection for domestic sales (similar to ours) and for exports. In the latter case, EPR for exporters becomes, in the authors' notation (Rouzet and Miroudot (2013), page 4):

[8] $$ERPE_{j,c}=\frac{-t_{jc,W}-\sum_{i,s}t_{is,c}\cdot a_{is,jc}}{1-\sum_{i,s}a_{is,jc}}$$

Where W stands for export market (the world) and c for home country. This is an interesting development of EPR analysis from a GVC perspective, but we cannot follow their example in our case because we made the conventional hypothesis that nominal protection raised all prices (imported and domestically produced goods) on domestic market by the value of the tariff. In this case, domestic products and competing imports are sold on the home market at the same price. The domestic producers are price takers; they adjust their price upwardly in case of tariffs on competing imports and enjoy a rent. Even from our standard theoretical stand-point, equation [8] raises interesting issues when the tariffs are not MFN but are preferences that vary according to the exports' country of origin. In this case, and as long as the competing products are substitutable, domestic prices can raise only by the lowest preferential tariff. Non preferential imports, dutiable at MFN tariffs, will be out-priced and trade diversion will occur, resulting in lower tariff revenues for the importing country.

We should note that, in theory, such an hypothesis of perfect substitutability of similar imports and may not be adapted in the case of Leontief production functions (inputs are complementary in such a framework, implying that little or no substitution can occur). As mentioned in Diakantoni and Escaith (2012), substitution is one of the weakest theoretical points of the EPR theory and an exhaustive discussion of the issue would require adopting a partial or general equilibrium framework. For practical reasons, when calculating effective protection at preferential rates, we decided to maintain the MFN valuation for the price of competing domestic inputs.

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 analyzing trade policy from a "trade in value added" perspective (Diakantoni and Escaith, 2012).

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. Tariff duties do influence the domestic price of all inputs, including domestically produced ones (Box 2

[8] 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.

again). 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.

2.4 EPRs, services and global value chains

Because nominal protection implies a tariff on the import of goods, EPR theory has traditionally focused its attention on trade in merchandises. Moreover, as trade in services was still marginal in the late 1960s when this theory was formulated, services were considered as non-tradable and included in the domestic value-added (in other term, the technical coefficients [a_{ij}] considered in equation [4] includes only the inputs from industries producing goods). Yet, one of the most striking results of the trade in value-added research programme has been to considerably resize the weight of services in international trade and, even more importantly from a policy perspective, to highlight their role 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 duplicates in value-added its Balance of Payments valuation. Moreover, the cost and quality of GVC-related services, both embodied and imbedded, are key components for defining the competitiveness of any given industry and its capacity for up-grading the value-chain (Low, 2013).

For 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 is described by the left-hand side of equation [7]: unless they accept to operate at lower gross margins than their international competitors, they are not competitive on the international market; similarly, exporting firms making use of their services at home will suffer a cost-disadvantage. [9] By increasing the relative price of non-tradables with respect to tradables, tariffs act here as a kind of over-valued real exchange rate.

2.5 EPRs, trade in value-added and the densification of domestic industrial network

One option for correcting the anti-export bias due to high nominal and effective protections has been to establish duty-free EPZs. Another option is to implement draw-back schemes where domestic firms can have the duty taxes paid on inputs reimbursed when they export their products. Nevertheless, as we shall see, this mitigating strategy is insufficient in the case of fragmented production network.

Distinguishing between the costs of domestic and foreign inputs, EPR can therefore be written as:

$$EPR_j = \frac{t_j - [\sum_i (t_i . a^f{}_{ij}) + \sum_i (t_i . a^h{}_{ij})]}{1 - \sum_i a_{ij}} \quad [9]$$

With a^f_{ij} and a^h_{ij} 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 $[\sum_i (t_i . a^h_{ij})]$ in equation [9]) 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 [10]) when they source some of their inputs from other local suppliers or outsource part of their tasks to them: **[10]**

$$\left(1 - \left[\sum_i a^f{}_{ij} + \sum_i (t_i . a^h_{ij})\right]\right) < \left(1 - \sum_i a_{ij}\right) \quad [10]$$

[9] 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).

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

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 [10] becomes an identity as $a^f_{ij} \equiv a_{ij}$; $\forall$ 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 [9] is a well-known result from a traditional trade in final goods perspective, our new corollary [10] is relevant only from the vertical specialization perspective typical of GVCs, where a "buy" decision arising from a "make or buy" assessment implies arbitraging between domestic and foreign suppliers.

Table 1: Nominal protection and effective protection rates in East Asia and the Pacific, 1995-2005 *(*percentage, *ad valorem)*

	Developing Countries				Developed Countries			
Sector	*Agriculture*		*Manufacture*		*Agriculture*		*Manufacture*	
Year	1995	2005	1995	2005	1995	2005	1995	2005
NP Median	6.5	3.9	9.2	6.2	1.3	1.9	2.3	1.3
NP Average	27.2	11.9	15.9	7.8	2.0	2.1	4.0	2.9
EPR Median	4.9	2.6	14.7	10.6	0.9	3.1	3.5	1.8
EPR Average	29.6	15.5	26.3	16.6	1.1	3.9	8.3	5.8

Note: NP: nominal protection; EPR: effective protection rate.
Source: Diakantoni and Escaith (2012) based on ten countries IDE-JETRO Asian input-output matrix and WTO tariff data.

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".[11] East Asian developing countries reviewed in Diakantoni and Escaith (2012) did follow the expected policy of lowering EPRs, as shown in Table 1. 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 weighting for trade flows. As the protection on industrial inputs purchased by farmers decreased, they benefited from higher EPRs.

2.6 Critics and new implications in a TiVA perspective

After revising the main policy dimensions that motivated our research and before looking at our results, a few words should be said on the controversies related to EPRs. The theory of effective protection was fashionable in the 1960s and 1970s, but was quickly dismissed by most academics

[11] Quoted from "*The Globe and Mail*", 4 March 2010.

as lacking strong fundamental basis. Critics come from both orthodox and heterodox economists, even if in practice EPRs have been widely used by the two schools. [12]

A key assumption of EPRs is that there is practically no substitution between intermediate inputs or between intermediate inputs and primary factors. This assumption is present, for example, in the Leontief model which assumes perfect complementarity between primary factors (labour, capital) and the various intermediate inputs. While this assumption has some validity in short-term economics, it is clearly not the case when long-term effects have to be modelled. When long-run effects are taken into consideration in a general equilibrium context, two effects counteract to reduce the "effectiveness" of EPRs as theory: the substitution and the scale effects. The greater the substitution effects, the lower the demand for protected goods as demand shifts to lower-priced products. Thus, the effective positive protection provided to the priority sectors will be overstated by the EPR formula, while it will be the opposite when the EPR results in a negative value. In presence of significant scale effects, the lower demand resulting from higher nominal protection may reduce production volumes and increase production costs in such a way as to considerably mitigate (or even reverse) the intended effective protection on the sectoral value added.

As we mentioned in Diakantoni and Escaith (2012), despite these shortcomings, the calculation of effective rate of protection remains widely used by practitioners, and also by policy analysts. There are several reasons behind the resilience of EPRs:

— *First*, it remains a synthetic descriptor of the past or present arbitrages caused by the applied tariff schedule on each sector of the economy. The input-output matrix observed in a certain point of time is the outcome of the resources and technology available at that time, plus the end result from all the substitution effects that took place due to the application of the nominal tariff structure. Provided that the base year chosen for establishing the national accounts is close to a "steady-state" (free to recent real or nominal shocks such as natural disasters, changes in tariff duties or nominal exchange rate), the EPRs calculated with the observed input-output coefficients give a synthetic and unbiased picture of the net economic impact of nominal tariffs on productive sectors. [13] In particular, it provides a good estimate of transfer of income across sectors and the resulting anti-export bias resulting from the nominal tariff schedule. It is also a relatively simple measure to understand, compared to other "simulated" estimates of market distortions. [14] Thus it is, from a purely descriptive point of view, an excellent aggregate tariff indicator.
— *Second*, the standard definition can still apply (with some restrictions) to partial equilibrium economic models, thus partially legitimize the approach for trade policy (Ruffin, 2008). Moreover, the apparition of computable general equilibrium models in the 1990s reinserted EPRs as *bona fide* indicators for synthetizing the aggregate impact of changes in nominal protection rate on the production structure and the transfer of income among sectors and agents. In particular, CGEs make possible the conduct of sensibility analysis, to measure the impact of substitution effects on the predictive power of EPRs.

Heterodox economists would rather criticise the implicit assumption of a single "market price" for internationally tradable goods and the underlying hypothesis of profit maximization which means that the price of domestically produced tradable goods will rise in line with the nominal protection granted against the competition of substitutable imported goods. For most heterodox economists, in particular the Post-Keynesian school (Lavoie, 2014), prices are formed by adding a mark-up to production costs. Therefore, the domestic price of locally produced goods should increase only in proportion of the additional production cost of imported inputs. This cost-push effect is expected to be considerably lower than the full nominal protection granted on competing imports: The sum $[\Sigma t_{i.} a^{h}_{ij}]$ in the EPR equation [9] is now close or equal to zero and the resulting EPR is higher than in the conventional "mainstream" approach.

[12] EPR theory was born in the mainstream schools of (partial equilibrium) economics but was also at the core of Industrialization by Import Substitution, a protectionist policy widely employed since the 1960s by most developing countries under the influence of heterodox economists and still advocated today in some quarters under the notion of "policy space".

[13] We will measure, later in the paper the possible bias generated by short-term nominal exchange rate movements, under the assumption that real exchange rates tend to return to their initial value.

[14] Most alternative indicators are based on some estimate of the welfare cost of tariffs, and include elasticities of substitution in partial or general equilibrium framework.

The heterodox criticism is much more fundamental if it implies that each individual firm has its own cost and price structure. Confronted to higher tariffs on their market of destination, leading firms may decide to lower their profit margin (no impact on the domestic price of the imported goods) or domestic competitors may opt for not reflecting the nominal protection on their gross margin (value-added) but increase their market share by under-pricing the competing imports. At the extreme, situation may vary from industry to industry and firm to firm, making difficult their aggregation into the single cost and value-added equation which is at the core of the EPR calculation. Ultimately, no general conclusion can be derived from tariff schedules and the impact of tariff schedules on value added would be a purely case-by-case empirical issue.

Curiously, this heterodox view may not be far away from the mainstream new "new" trade theory insisting on firm heterogeneity and the semi-oligopolistic market structure of "trade in varieties". Here too, the economists' contribution boils down to empirical research based on micro-data at firm level. Nevertheless, most heterodox economists would probably agree that firms in semi-industrialised countries act more as price taker and adjust their output price in function of the competing imports. Thus, EPRs would remain empirically valid at least in the case of developing economies.

3 EVOLUTION OF NOMINAL AND EFFECTIVE PROTECTION SINCE THE URUGUAY ROUND

The section presents the main results obtained for the wide selection of countries included in the OECD-WTO *TiVA* database since the signature of the UR agreement (1995) and up to the global crisis of 2008-2009. The *TiVA* matrix in its May 2013 release – see Annex 2- contains thirty seven sectors of which twenty sectors on goods and the remaining seventeen on services. The matrix provides details of inter-industrial linkages for 53 economies (all OECD countries, Argentina, Brazil, Bulgaria, China, Chinese Taipei, Cyprus, Hong Kong-China, India, Indonesia, Latvia, Lithuania, Malaysia, Malta, Philippines, Romania, Russian Federation, Saudi Arabia, Viet Nam, South Africa and Thailand) for the years 1995, 2000, 2005, 2008 and 2009. We did not use the 2009 data available in the *TiVA* May 2013 release as too much affected by temporary shock resulting from the global crisis. [15]

3.1 Calculating the Nominal and Effective Protection Rates

The nominal protection rates (NP) are calculated as weighted tariff averages with data sourced from the WTO Integrated Data Base (IDB) and complemented by the WTO-ITC-UNCTAD World Tariff Profiles and the UN Comtrade databases. EPRs are derived from equation [1]; technical coefficients a_{ij} were calculated as the share of the intermediate inputs, domestic and imported, in the final output and are sourced from the joint OECD – WTO Trade in Value-Added (*TiVA*) database.

NPs and EPRs were calculated for all good producing sectors for the years 1995, 2000 and 2008 first by assuming MFN (most favoured nation) treatment to all partners. The MFN dataset for the 3 reference years includes 41 economies as some economies were dropped from the dataset either because tariffs and imports were not available for all the three years or because an important number of duties were expressed in *non-ad valorem* terms. The nominal protection rates (NPs) and the EPRs were calculated again for the year 2008 by including preferential duties and also *ad valorem* equivalents. [16]

As mentioned in the previous section, the contemporaneous approach of trade in tasks gives a crucial role to services, both as trade facilitators and as contributor to the value-added created by participating firms. EPRs were also imputed for the services' sectors adapting equation [1] according to the Balassa formula (the denominator excludes the intermediate consumption of services from the calculation of value-added). Because NP is null – no duties are collected on services- the EPRs for these sectors are all negative – see Annex 4-.

[15] The 2015 *TiVA* release that was under preparation at the time of finalizing this paper will expand data coverage up to 2011.

[16] Preferential and MFN ad *valorem* equivalents are calculated based on bilateral trade statistics, see the technical annex on "Methodology for the estimation of *non-ad valorem* tariffs" in ITC, UNCTAD and WTO (2007) "World Tariff Profiles"

3.2 Evolution of the 1995-2008 MFN protection

This section provides some empirical evidences and facts about the distribution of the MFN protection, nominal and effective, of the goods sectors across time. By distinguishing between primary and manufactured sectors and by level of development, Table 2 presents the number of goods' sectors benefitting from the tariff schedule (the effective protection is higher than the nominal) from those which are relative or net losers (effective protection lower than the nominal).

Table 2: Effective and nominal protection, by main sectors, level of development, all years

		Count			EPR>NP	EPR negative	
Sector	Status	EPR>NP	EPR<NP	Total	*share*	Count	*share*
Primary	DVD	81	105	186	*44*	93	*50*
	DVG	41	19	60	*68*	9	*15*
Manuf.	DVD	1275	398	1673	*76*	190	*11*
	DVG	431	109	540	*80*	63	*12*
	Total	1828	631	2459	*74*	355	*14*
	share	*74*	*26*	*100*			

Note: EPR: Effective protection rate; NP: Nominal protection (MFN applied tariffs); Primary (agriculture and mining, Manuf: manufactures. DVG: developing countries, DVD: developed economies. Data coverage includes 31 developed countries and 10 developing economies.
Source: Authors' calculation

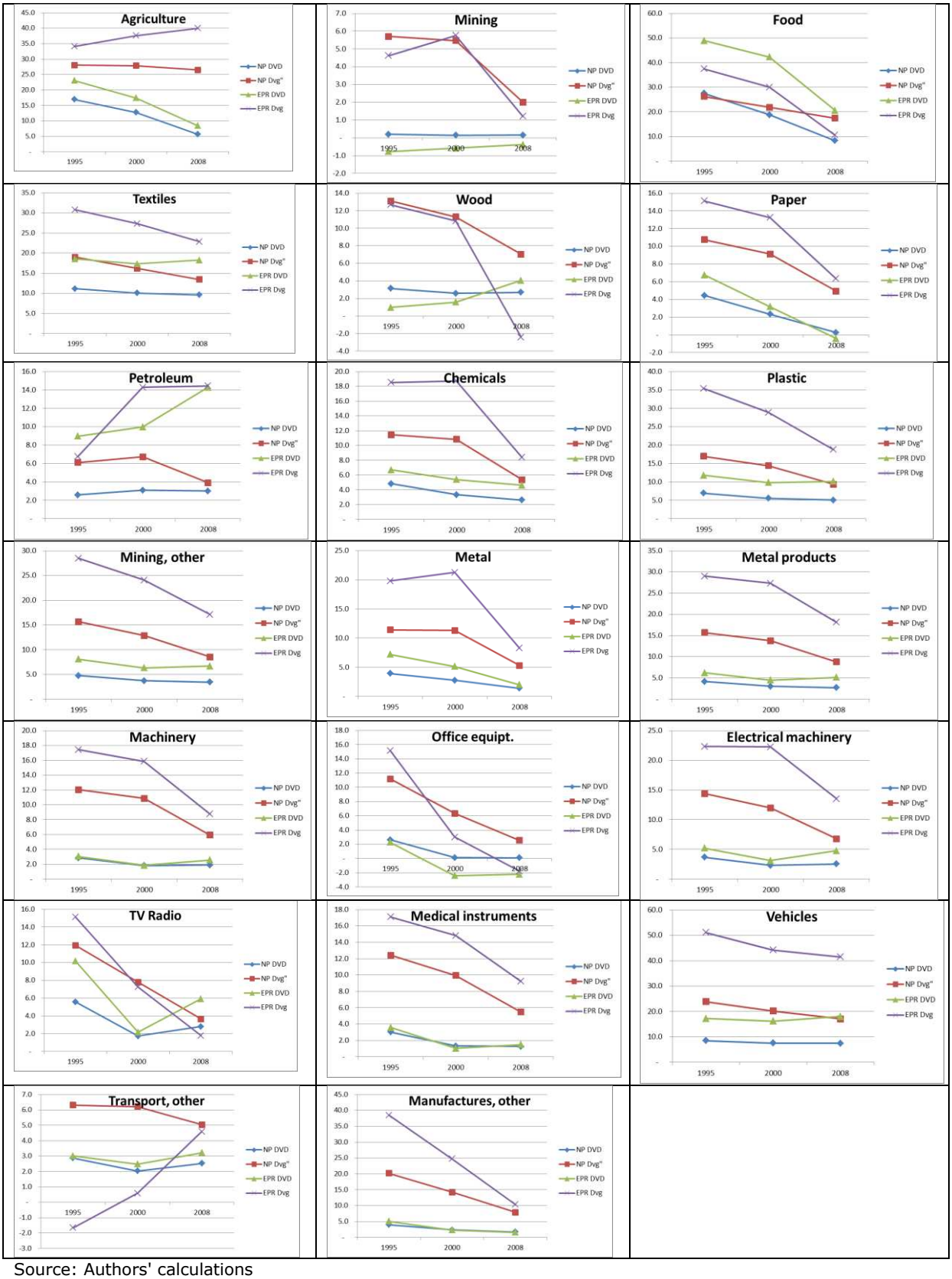
Developing countries have in relative terms more protected sectors, as the effective protection is higher than the nominal in both, primary and manufactured goods. However, the number of EPRs larger than NPs in developed countries remains significant for a number of sectors. At the same time, half of their primary sectors –mainly raw materials- present negative effective protection, against about 15% only for developing countries.

Looking at the average protection over the years, as shown in Figure 2, the effective protection is often greater than the nominal. In particular, the manufactured sectors benefit from enhanced effective protection in developed and developing countries, contrary to the primary sectors where enhanced protection is observed only in developing countries. Non-Agricultural primary sectors suffer from poor protection in developed countries and half of them suffer from negative protection.

From the trends of protection illustrated by Figure 2 in developed and developing countries, Agriculture emerges as an outlier with an increasing EPR in developing countries in opposition to a decreasing EPR in developed countries. Developing countries seem to have decreased the nominal protection of Agriculture but also the cost of intermediates in that sector; moreover, the modernization of agricultural techniques in developing countries implied a more intensive use of commercial inputs and a lower rate of value-added by unit of output (i.e., a smaller denominator in the EPR formula). The net effect of these changes concurred in determining a higher rate of effective protection. However, this trend is to be considered cautiously, because in-quota duties and *ad valorem* equivalents were not included in the MFN analysis calculation; these specific characteristics would have made a difference in the case of Agriculture. Besides Agriculture, the only sectors benefitting from an increased effective protection in 2008 are Petroleum and Other Transport equipment.

In absolute terms, the highest EPRs are observed in Food, Vehicles, Other Manufactures, Plastic and Metal products. In these sectors, developing countries EPRs are the highest, Food being an exception because developed countries tend to particularly protect this sector. Besides Food, developing countries seem to protect less Wood and TV Radio sectors than the developed countries. Very low EPRs are observed for Office equipment and TV Radio sectors in both developed and developing countries, certainly due to the WTO ITA agreement.

Figure 2: Effective and nominal protection, by sector and level of development



Source: Authors' calculations

3.3 Intermediate inputs and the impact of tariffs on the production cost

The availability of I/O matrices and the global value chains data illustrate trade interconnections between sectors and across countries. A tariff, even if it is insignificant, can have an important impact as intermediates can cross the borders several times before the finalisation of the product (Rouzet and Miroudot, 2013).

Tariff duties do influence the domestic price of inputs, be they imported or domestically produced. In effect, domestic producers 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. Thus, any domestic industry "j" will benefit directly from the tariff applied to the goods it produces (t_j) but will suffer an additional cost equal to the weighted average of its intermediate consumption ($\sum_i t_i \cdot a_{ij}$), including those purchased domestically.

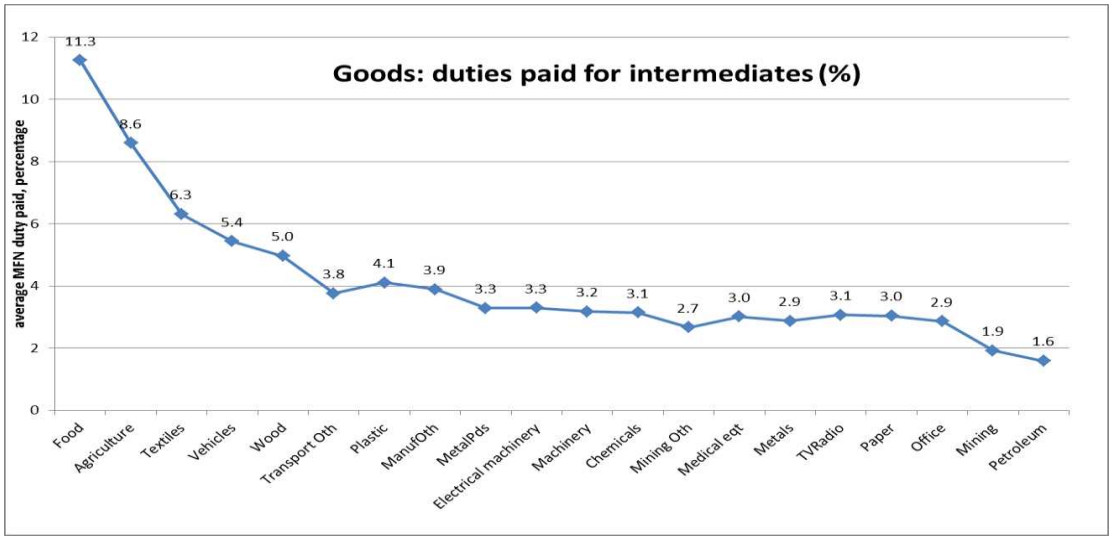
Thus, the analysis of the average tariff paid for intermediates can reveal aspects of the domestic policy that could eventually be optimised from a supply chain driven world. In that perspective the average cost of duties actually paid for the purchased intermediates for the production of one unit of output in sector j, was calculated by using the following formula:

$$C_j = \frac{\sum_{k,i} t_{k,i} * a_{k,i}}{\sum_{k,i} a_{k,i}} \quad [11]$$

where j= the production sector, i= the sectors from where intermediates are sourced, K= the country of origin, $a_{k,i}$= the flows of intermediates sourced from the I/O matrix from sector I and country k.

Note that, at the difference of the EPR formula in [1], equation [11] includes only the duties paid on imported inputs and disregards the additional production cost that producer have to pay when domestic suppliers increase their price to benefit from the protectionist rent (see Box 2 again). Figure 3 illustrates for the 20 good-producing sectors the cost of customs duties on the inputs necessary for the production of output, considering an MFN scenario. Sectoral situations differ widely, with a duty-related cost varying from 1.6% to more than 11%.

Figure 3: Goods - Average duties paid for intermediate inputs by industry (1995-2008 average)

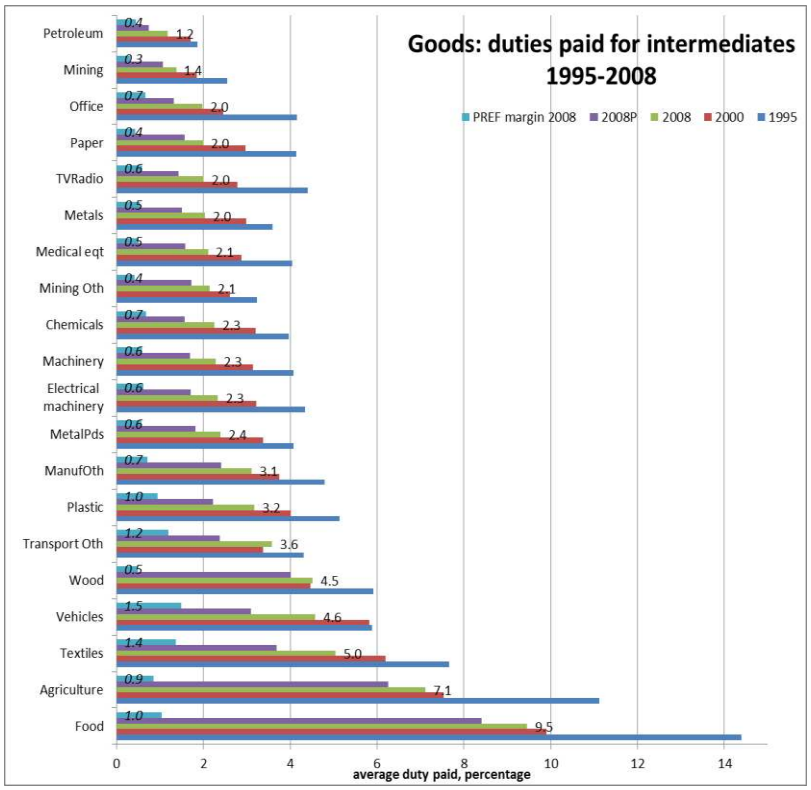


Source: Authors' calculations

Figure 4 illustrates changes in MFN duty-related costs between 1995, 2000 and 2008. For 2008 the calculation includes also the impact of preferential treatments. Costs were obviously reduced from 1995 to 2008, and in some of the sectors, quite significantly. Petroleum and Mining, two upstream sectors, pay less in duties charged on their imported intermediates. This low cost declined in time,

to less than 1.5% to the production cost in 2008 at MFN duties. The use of preferences further reduced this cost by 0.4% and 0.3% respectively for Petroleum and Mining.

Figure 4: Goods - Average duties paid for intermediates by sector (1995, 2000 and 2008)



Note: The 2008 cost of MFN duties appears in the graph and the reduction due to the related preferential margin is *in italics*.
Source: Authors' calculations

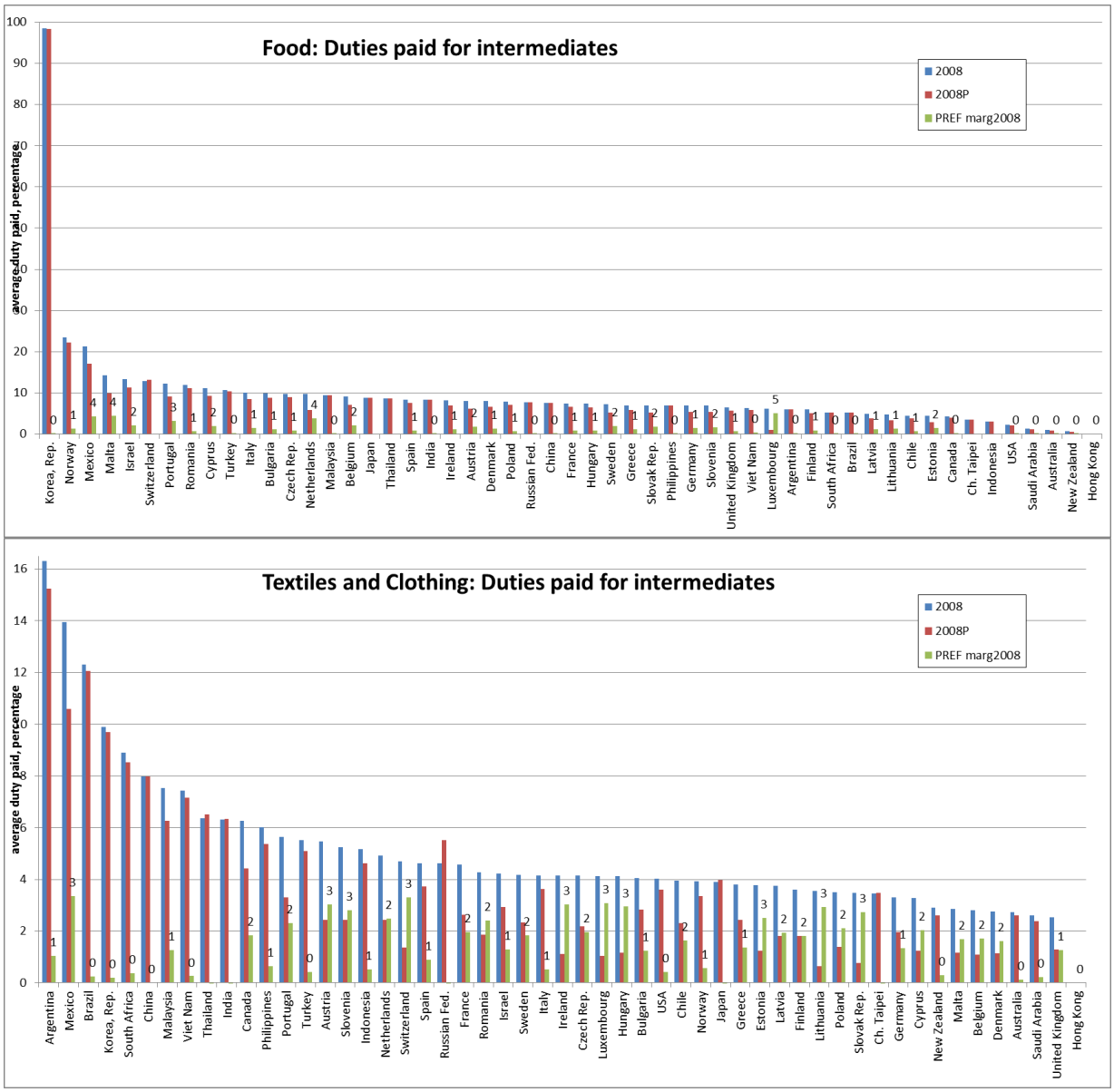
At the other extreme, Food and Agriculture industries (Figure 5) bear the highest additional cost related to duties paid for intermediates. In 2008, the estimated average MFN duty included in the production cost for Food was about 9.5% and for Agriculture 7.1%. For both sectors, the use of preferential schemes reduced these costs by 1% in average. Textiles, Vehicles and Wood show also relatively high costs with average duties paid for intermediates around of 5% and with a gain of 1.5% due to preferences for Textiles and Vehicles and a gain of 0.6 for Wood.

Costs are very different when we look at individual countries (Figure 5). For instance, in the Food sector Korea is an outlier with an average cost of 99% (and no preferential margin); followed by Norway with 23% and Mexico with 21%. Interesting to observe that Australia and New Zealand - big food producers- import duty free all the intermediates needed in the Food sector, showing a coherent domestic policy with the country's economy.

In Agriculture Korea is the country that charges most for its intermediates with an average cost of 37% (and no preferential margin), followed by Norway 20% (no preferential margin), and Mexico 19% (preferential margin of 4%). Same scenario as for Food, the big agricultural producers, Australia and New Zealand import duty free all the intermediates needed in the AG sector.

In Textiles and Clothing, Argentina (average MFN cost of 16%), Mexico (14%), Brazil (12%), Korea (10%), China (8%) charge most important duties to their intermediates with very low or null preferential margins. Their inputs seem to be imported from countries where they haven't signed preferential agreements. Even if countries rely to domestic intermediates, the results highlight those countries where domestic policies charge high tariffs on intermediates. (The results on USA are not relevant as textiles preferences are in HS chapter 98).

Figure 5: Average duties paid for intermediates by country (1995, 2000 and 2008)



Source: Authors' calculations

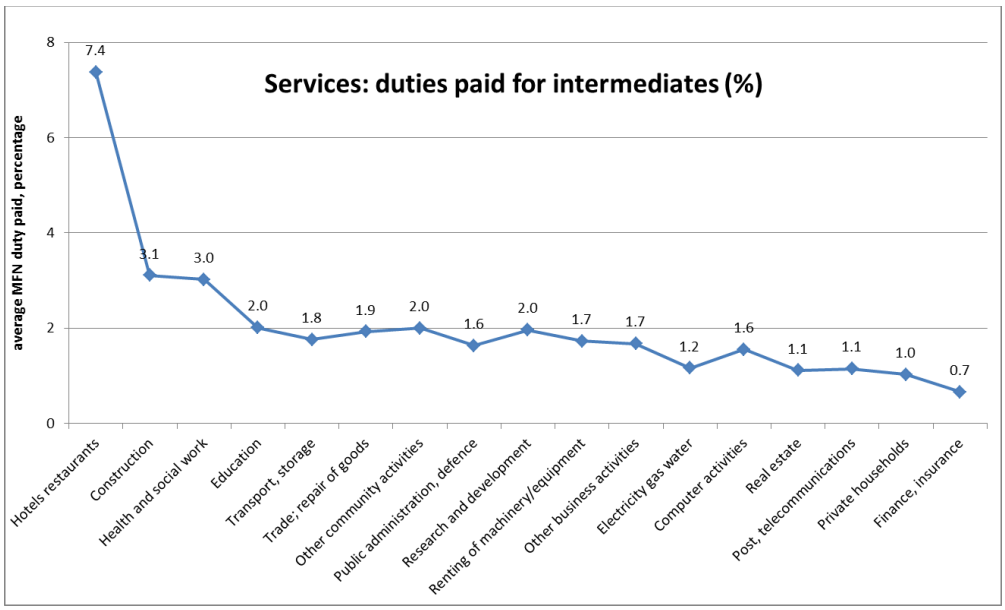
3.4 Nominal protection and the production cost of services

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, as in Figure 3 above.

The calculation of the costs of MFN duties paid for intermediates for the 17 sectors of services provided in the I/O matrix are displayed in Figure 6. Costs for duties paid for intermediates are part of the Services production cost and are incorporated in their value. Overall in the Services' sectors, the average cost of duties paid for purchased intermediates varies from 0.7% to more

than 7%. Compared to the costs observed in the Goods sectors costs are less important. However some specific sectors and countries producers of services incorporate important costs related to duties.

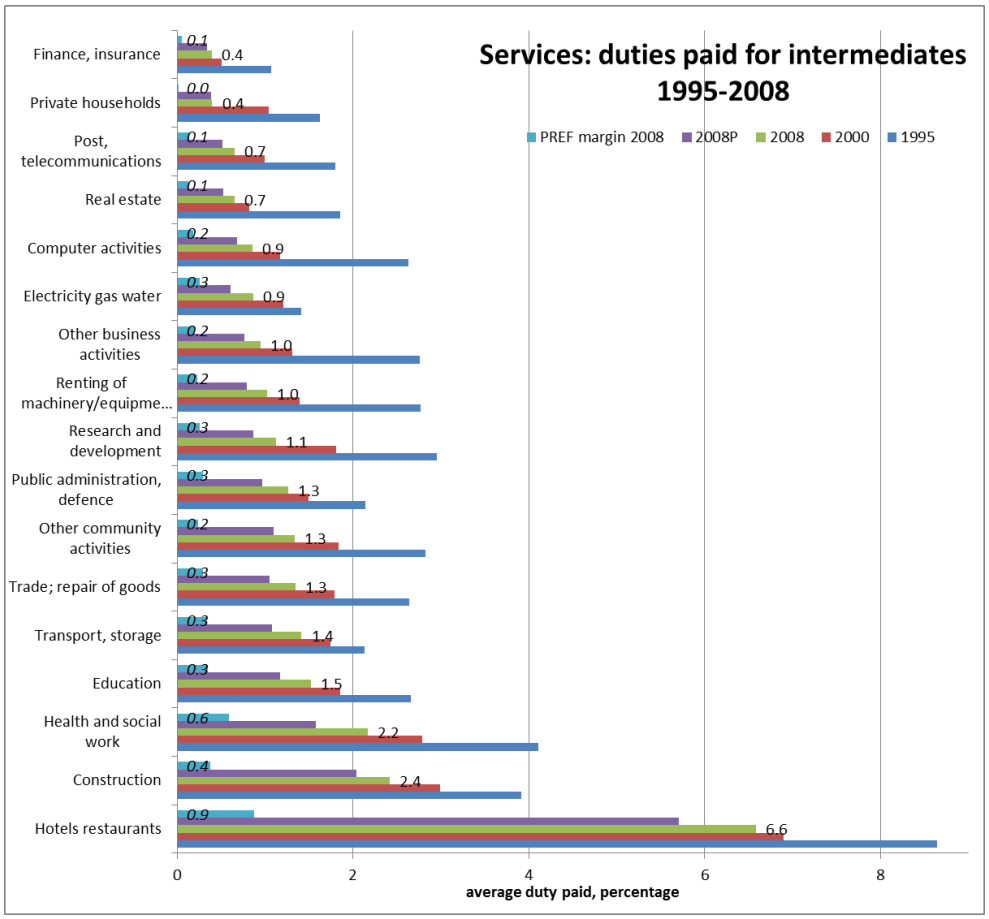
Figure 6: Services-Average duties paid by services sector for intermediate consumption (1995-2008 average)



Source: Authors' calculations

Figure 7 illustrates the cost of MFN duties paid for intermediates for the years 1995, 2000 and 2008; for the year 2008 the cost the cost of duties paid for intermediates including preferential access is also estimated. Hotels and restaurants providers suffer from the highest cost related to duties (6.6% in 2008) even if preferences are used (5.7%), probably because their intermediates come from much protected sectors such as Food and Agriculture. In average, the cost related to duties in the Construction services and Health services is estimated around 2.2-2.4%; For Education and Transport services the average cost paid for intermediates is estimated around 1.5% with an average gain due to preferences of 0.3%.

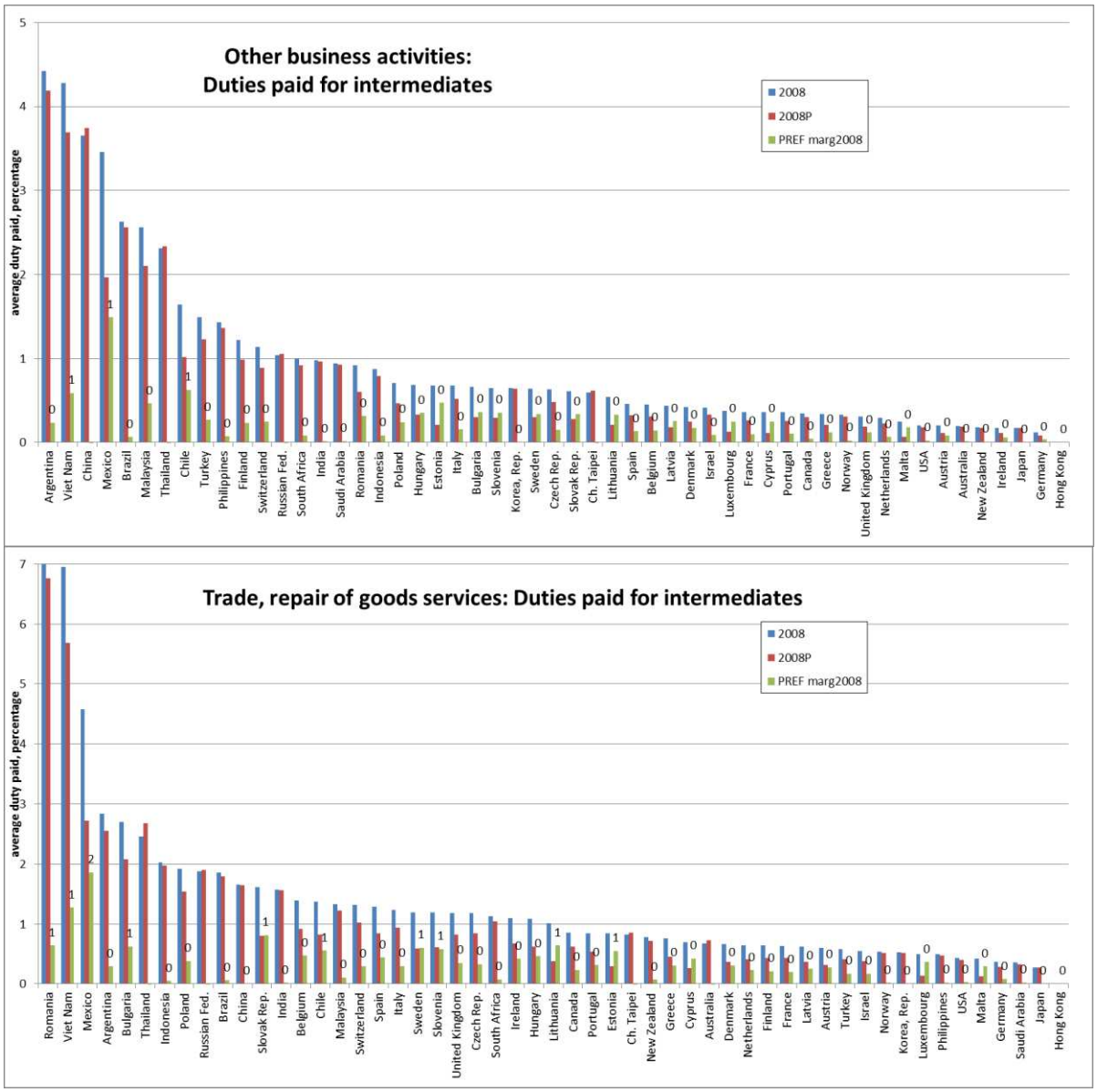
Figure 7: Services - Average duties paid by the services' sectors for intermediates (1995, 2000, and 2008)



Note: Duties are sorted by descending order for year 2008. The 2008 MFN duty appears in the graph and its preferential margin *in italics*.
Source: Authors' calculations

It's interesting to observe in Figure 8 that tariff-induced costs have been reduced significantly from 1995 to 2008, and in some Services sectors are very low (Finance, Private households). Services have also benefited indirectly from the conclusion of preferential schemes in goods but still embrace costs related to duties. Argentina, Mexico, Viet Nam, China and Brazil are in the top-5 list of countries paying high duties for intermediates in Other Business services, Computer activities or Renting machinery services. In Trade and repair of goods services, Romania and Bulgaria, just after having joined the EU, are in top-5 list of countries paying high duties for intermediates.

Figure 8: Services - Average duties paid by Trade and repair of goods services sector for intermediates by country (2008)



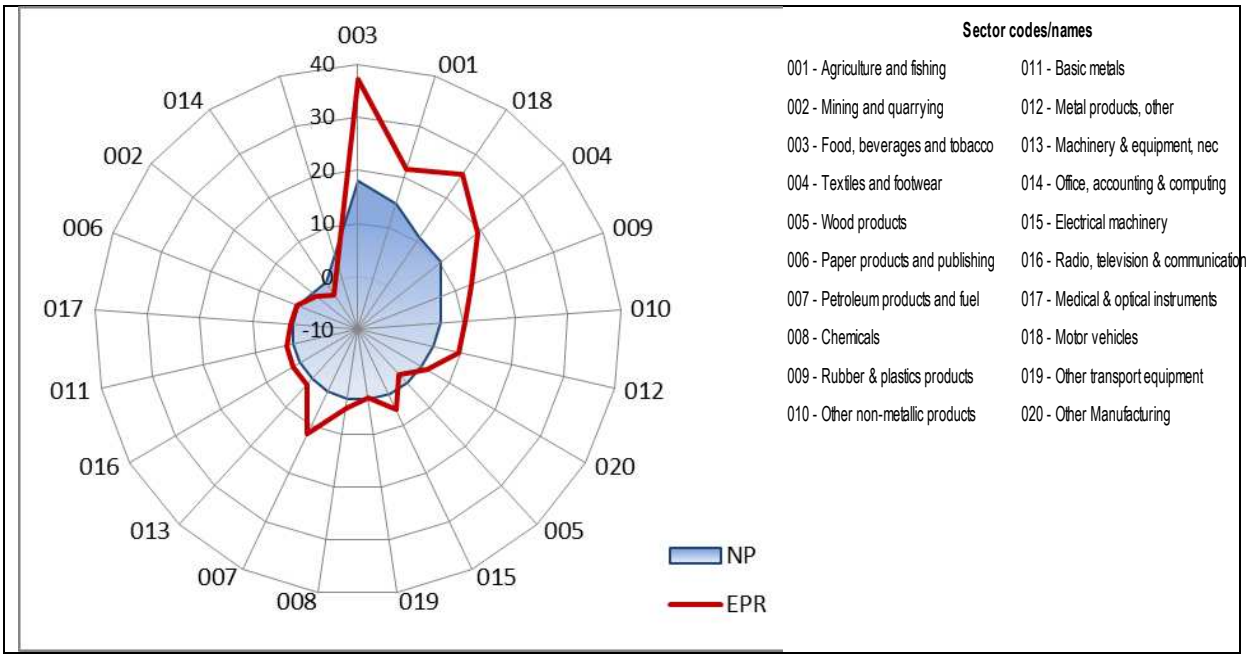
Source: Authors' calculations

3.5 Overview of MFN and Preferences: from goods to services

The highest 2008 nominal protection on good producing sectors [17], in average of all countries covered by the *TiVA* database, is found in the food and beverage sector (003), followed by agriculture (001). Their effective protection rates are also high, especially for food and beverage. At the difference of agriculture, the primary sector of mining and quarrying (002) 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 inputs). The situation of manufacture products varies; automobiles (018) are usually highly protected, office and computing equipment (014) is the least protected of all sectors, suffering from a negative effective protection of -2%.

[17] Includes ad *valorem* equivalents.

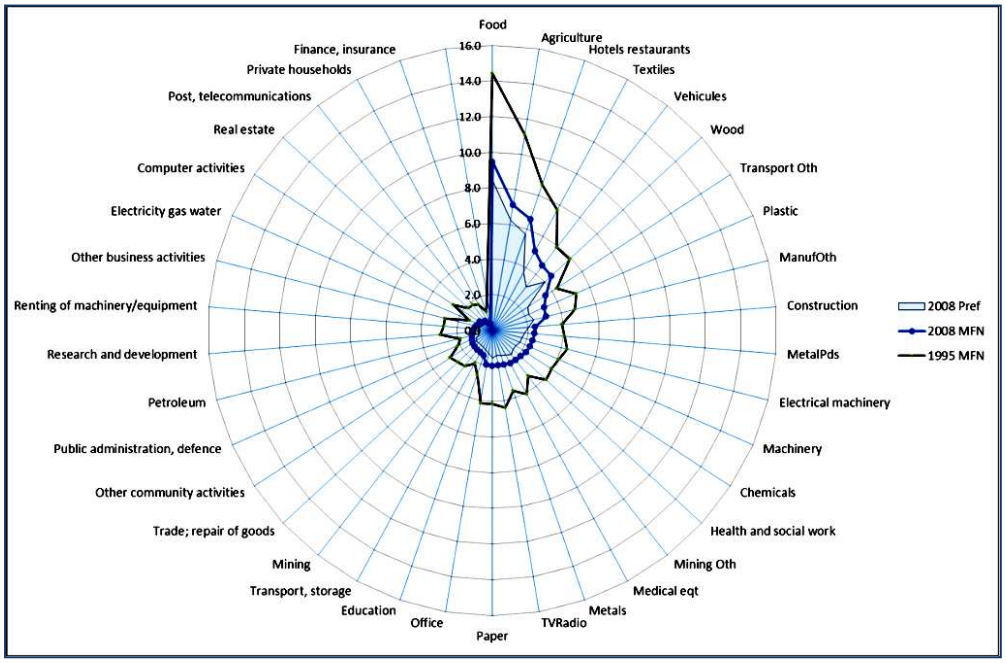
Figure 9: Average nominal and effective protections, 2008



Note: Simple average of countries, on the basis of MFN applied tariffs.
Source: Authors' calculations

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. Figure 10 presents the results obtained for all sectors and the impact of preferences (lower duties than the MFN treatment). Preferential tariffs are applied to the bilateral flows of inputs that are fully identified in an international input-output matrix.

Figure 10: 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.

When analysing the graph and comparing it with Figure 9, 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 9) 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.

4 UNDERLYING PATTERNS IN NOMINAL AND EFFECTIVE PROTECTION

The present section explores the existence of possible relationships between trade policy (as captured by nominal and effective protection) and structural economic factors. NPs, EPRs and other tariff-related impacts such as the costs of intermediates are analysed within their socio-economic context. Exploratory data analysis techniques, such as principal components analysis (PCA) are used on detailed 2008 data to proceed to a first examination of possible determinants influencing tariff policies. In absence of a strong theoretical a priory on the economics of EPRs, EDA is a god alternative, considering that the number of potential explanatory variables is relatively high.

Principal Component Analysis is used to reduce the complexity of the p-dimensional space corresponding to the various trade policy variables to a lower dimensional space while preserving as much information as possible. A set of new synthetic variables (called principal components) is constructed, with the aim of capturing most of the information *(id est*, the variance). The principal components (also called factors) are mutually independent. There is, in theory, as many principal components than variables, but some components explain much more variance than others.

A series of structural socio-economic variables and macroeconomic indicators are related to the tariff-policy indicators. 17 socio-economic variables are included and sourced from the World Bank's World Development Indicators. [18] They include the size of the economy in terms of population and GDP, the average per capita income, the source of value-added (agriculture, industry, services), the importance of trade relative to GDP, the importance of high-technology exports, the importance urban population and the natural resources rents.

4.1 Exploring the underlying economic patterns of MFN protection

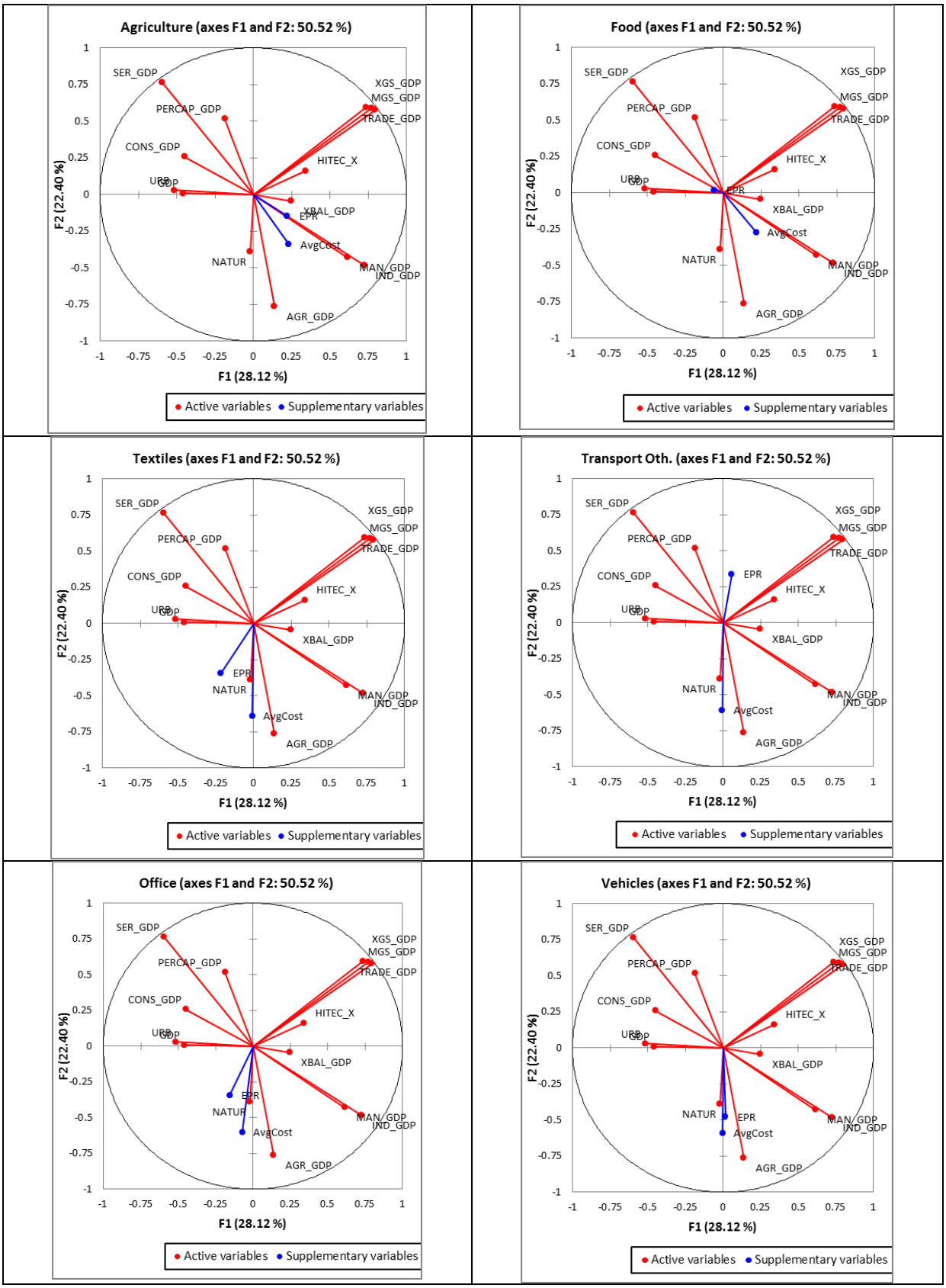
EPRs and average costs of intermediates due to MFN protection in 2008 are projected in the space of the socio-economic variables using PCA. The first two components explain more than 50% of the total variance, with the first main component capturing 28% of the variance while the second 22%. A word of caution is therefore necessary: the correlations are significant but not overwhelming.

- The first component F1 (horizontal axis) is associated with trade openness and income; economies trading goods would appear at the right side of the circle, whereas economies trading mostly services would appear on left side of the circle. Large GDP and high per capita income countries will be found at the left-hand side of the circle.
- The second component F2 (vertical axis) is associated with the predominance of natural resources and agriculture; rural countries that have important primary sectors, agriculture and natural resources will be found at the bottom part of the circle.

Figure 11 presents the PCA results for selected good-producing sectors.

[18] Three of the socio-economic variables are available only for 2008 – see Annexes -.

Figure 11: PCA analysis for selected sectors –projection of EPRs and Cost of intermediates (2008)



Note: See Annex 3 for a description of variables.
Source: Authors' calculation

EPRs and duty-related additional costs of intermediates in Agriculture and Textiles & Clothing are important in rural countries and natural resources countries. EPRs are positively correlated with the share of manufactures industries in GDP. Rich countries and services oriented economies show a low correlation to EPRs and costs of intermediates.

In the Food sector the costs of intermediates seem equally correlated to agricultural or manufactured oriented economies. On the other hand, EPRs are not strongly correlated with a particular profile, besides being somewhat opposed, in the graph, to the variables defining larger, urbanised and richer economies.

Other Transport Equipment presents an interesting situation: EPRs are rather important in developed economies and in economies oriented in trading goods or services. Developing countries show a strong correlation with the average cost related to tariff duties. This is a situation where high effective protection is not correlated with high nominal duties.

In all sectors, the costs of intermediates seem highly correlated to primary economies mainly oriented to agriculture and to natural resources. This relationship and the associated patterns might change when preferential schemes are included in the calculation in the next section.

4.2 The drivers of effective protection

Building on the previous results, the present section will profile tariff policies (MFN and preferential nominal tariffs and EPRs) using *TiVA* and structural economic indicators. Again, our tools are those of exploratory data analysis: Principal components, clusters and exploratory regressions.

4.2.1 In relation to Trade Policy variables

Our objective is to do a profiling of the various economies grouping them according to their trade policy indicators, then to explore the policy dimensions in order to understand the grouping.

- **Clustering**

The first procedure is Agglomerative Hierarchical Clustering, an iterative EDA technique used to build "homogeneous groups" of observations on the basis of their characteristics as given by a set of variables. The agglomerative approach successively unites pairs of individual observations and then sub-sets of observations, according to their similarities. Starting from all individual observations in the sample, it ends up with successively linking all individual observations into a single class. Where to truncate the resulting tree between these two extremes and define an optimal number of clusters can be determined by a combination of parametric methods building on variance decomposition and – as often in EDA – expert's judgement. Robustness is checked by using alternative linkage dimensions.

The end-result of the clustering method is to group observations (countries in our case) according to their similarity with respect to the variables (tariff policy). In Table 3, the largest group (27 members) constitute the third cluster and gathers most European countries, plus Turkey which is closely associated to this region. Groups 5 and 4 correspond to outliers (Mexico and Korea, respectively).

The remaining two clusters are relatively loose ones: Cluster 1 is associated to commodity exporters and cluster 2 to services economies. But the split is not clear-cut: Cluster 1 also includes emerging countries and cluster 2 contains some manufacture exporters. In addition, Group 2 is made of a mix of developed and advanced developing countries while Group 1 (the most loosely tight cluster) gathers the rest of the observations. Korea, classified as an outlier, is nevertheless close to Group 2 while Mexico shares similarities with Group 3 (Table 3). [19]

[19] While the results do not explicitly indicate the source of similarities, one may draw similarities between the role of regional preferences within NAFTA for Mexico and similar regional arrangements for EU countries.

Table 3: Hierarchical clustering of observations according to Trade Policy variables

Ward's method

Class	1 (IDN)	2 (CAN)	3 (ESP)	4 (KOR)	5 (MEX)
Objects	12	12	27	1	1
Within-class variance	6405.50	4845.36	1439.16	0	0
	ARG	AUS	AUT	.../...	KOR	MEX
	BRA	BEL	BGR	IRL		
	CHN	CAN	CHL	ITA		
	IDN	CHE	CYP	LTU		
	IND	HKG	CZE	LUX		
	MYS	ISR	DEU	LVA		
	PHL	JPN	DNK	NLD		
	RUS	NOR	ESP	POL		
	SAU	NZL	EST	PRT		
	THA	SGP	FIN	ROU		
	VNM	TWN	FRA	SVK		
	ZAF	USA	GBR	SVN		
			GRC	SWE		
			HUN	TUR		

Complete linkages

Class	1 (IDN)	2 (EST)	3 (CHL)	4 (KOR)	5 (MEX)
Objects	8	42	1	1	1
Within-class variance	6543.53	3759.12	0	0	0
	ARG	AUS	JPN	CHL	KOR	MEX
	BRA	AUT	LTU			
	CHN	BEL	LUX			
	IDN	BGR	LVA			
	IND	CAN	NLD			
	MYS	CHE	NOR			
	RUS	CYP	NZL			
	THA	CZE	PHL			
		DEU	L			
		DNK	PRT			
		ESP	ROU			
		EST	SAU			
		FIN	SGP			
		FRA	SVK			
		GBR	SVN			
		GRC	SWE			
		HKG	TUR			
		HUN	TWN			
		IRL	USA			
		ISR	VNM			
		ITA	ZAF			

Source: Authors' calculations

The results obtained using the alternative complete linkage method (Table 3 panel b) provides additional information. In addition to Mexico and Korea, Chile can also be considered an outlier for the specificity of its tariff policy. While all participants to group 2 and some of group 1 merged with group 3 to form a single mega cluster of 42 members, the first cluster, still centred on Indonesia and prominently made of developing countries, confirm its specificity.

- **Principal Component Analysis on MFN variables**

Principal Component Analysis is used to reduce the complexity of the various trade policy variables and understand the rationale behind the clustering of economies. We limited the exploration to the first four principal components; all the analysis is done on year 2008. PCA was applied first to the 20 good-producing sectoral EPRs, pooling together developed and developing economies. Initial results led to treat Korea as outlier (this economy is still incorporated, but only as a supplementary observation and does not affect the calculation of the components).

When plotting the observations (economies) on the first two components, the points situated on the positive side of the graph include most developing countries, with Brazil and Mexico the most representative ones (Figure 12). On the left hand side, we find the developed countries but also Hong Kong and Singapore. Indeed, when estimating the contribution of each of the four components on the value observed for some economic variables of interest, high values of Per capita GDP are found to be very significantly dissociated from the right-hand side of F1 (t=-5.5).[20] Associated with the left-hand side of F1 are also the services-oriented economies (Services/GDP negatively associated with F1; t:-5.1). Those left-hand side economies are open (high Trade/GDP ratio; t:-2.6) and are attracting Foreign Direct Investment (FDI stock; t.-3.0). At the contrary, both natural resources endowment and Agriculture/GDP are highly associated with F1, same as Manufacture/GDP (t: 2.7).

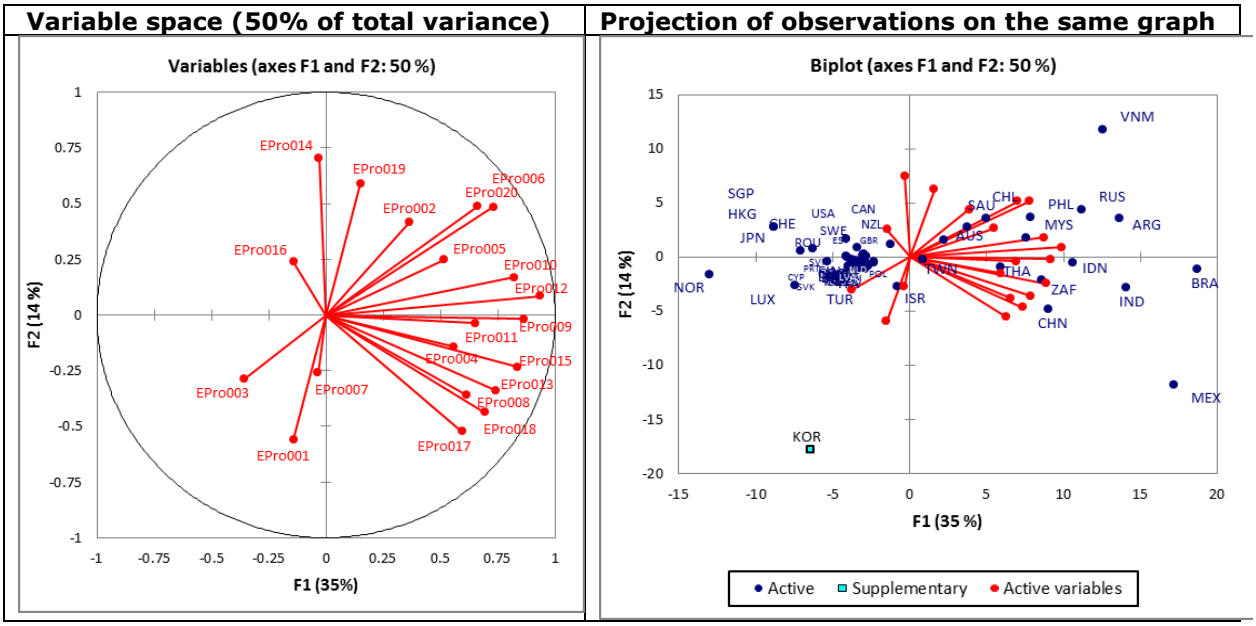
Treating Korea as an outlier helps separating the effective protection on sectors 03 (Food products), 01 (Agriculture), 16 and 14 (Communication and Computing equipment) and 07 (Fuels and refined petroleum) from the other sectors (19; Other transport equipment) being in a neutral

[20] Because the principal components are, by construction, mutually independent, estimates based on OLS regressions are well behaved, as are "t" statistics. But those regressions are not the product of theoretical models and the results should be considered as a complementary step to the EDAs.

position, slightly on the right-hand size. Korea, as supplementary observation, is now clearly in the left-hand side of F1, with most developed countries plus Hong-Kong and Singapore.

The second factor F2 indicates that high EPRs on 03 (Food products) are associated with high EPRs on 01 (Agriculture) and 07 (Fuels and refined petroleum). They are opposed to high EPR on 14 (Communication and Computing equipment), 19 (Other transport equipment), 20 (Other manufacturing), 06 (Paper products) and 02 (Mining). Vietnam is the most representative of positive F2 profile, while Mexico is on the opposite side of the graph (even when it does not influence the graph, Korea remains an outlier, far on the southern side of the graph).

Figure 12: Projection of sectoral EPRs on the first two principal components, Korea as supplementary observation



Source: Authors' calculations

A first result of this preliminary analysis is that, even if high effective protection (based on MFN applied tariff) is associated with developing countries (those which have, in general high bound and applied MFN tariffs, see Diakantoni and Escaith, 2009), some significant sectoral differentiation appear.

- High effective protection of industries relative to food products and, but less so, agriculture, communication and computing equipment as well as fuels and refined petroleum, is more common in industrialised countries or high income developing economies with relatively low natural resources endowment.

- The dipole Services orientation vs. Natural resources endowments appears as a key marker of effective protection policy, even after discarding the strong positive relationship between services sector orientation and high income cum low protection economies.

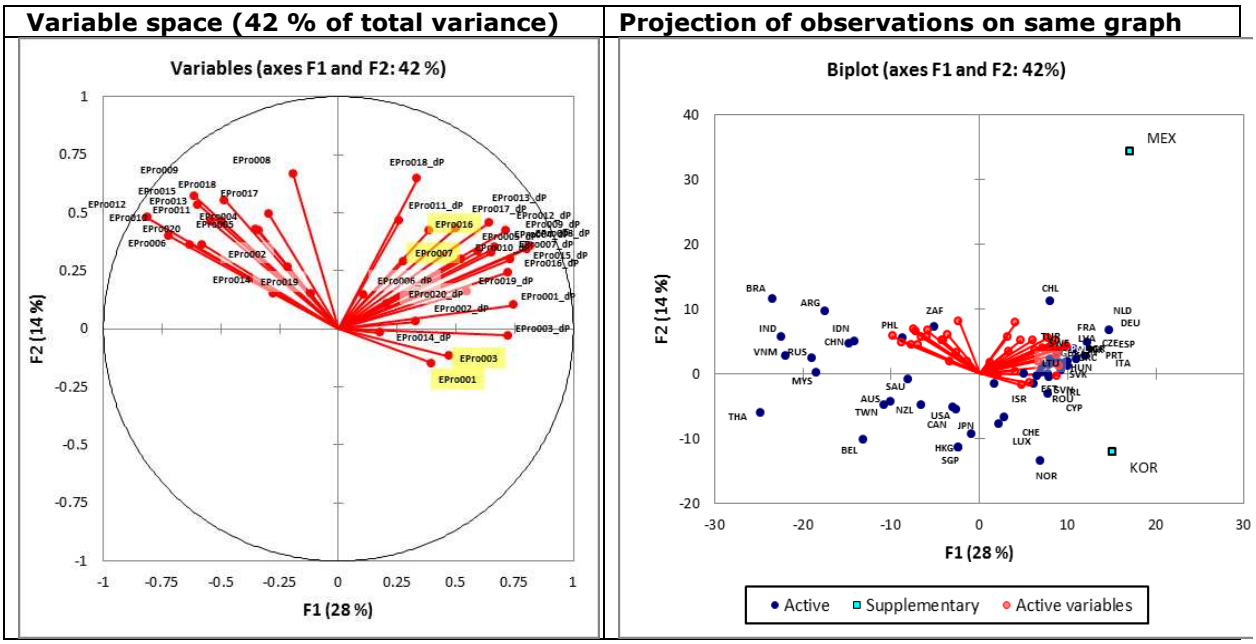
The influence of preferences on regional integration was made clear in WTO (2011): [21] global value chains and trade in value added are among the main factors explaining the rapid spread of preferential trade agreements in the recent years. The following paragraphs analyse sectoral EPRs when imports are dutiable under the best available tariff (preferential or MFN). In order to capture the influence of preferential treatment, the statistical analysis will consider the EPRs obtained under MFN and the changes in those EPRs attributable to the existence of preferential treatments. Those variables (EPR_D) measure the difference between EPR at MFN and EPR at best available tariffs. A positive value for the indicator signals that the effective protection increased due to preferences (i.e., that tariffs on inputs decreased more than tariff on output).

Figure 13 below presents the results of a Principal Component Analysis where Korea and Mexico -- two economies that appeared as outliers in initial analysis-- were included as supplementary

[21] WTO (2011) WTR on "RTAs"

observations. As mentioned, this allows neutralizing the strong leverage of those observations while mapping then according to the characteristics observed in all other observations.

Figure 13: Projection of sectoral EPRs and preferences on the first two principal components, Korea and Mexico as supplementary observation



Source: Authors' calculation

The first couple of principal components capture 42% of the variance and oppose clearly, for the first axis, the variables related to MFN EPR (on the left-hand side) from the variables related to preferential agreements (on the right-hand side). The second axis is more difficult to interpret. On the plus side, the variables with major tractions are the MFN EPRs of sectors 08 (Chemicals), 09 (Plastic products), 15 (Electrical machinery), 18 (Vehicles) and 17 (Precision instruments), and the changes in due to preferences for 18, 11 (Metals) and 17. On the negative side of F2, there are very few variables and they show little or no traction: mainly the EPR on sectors 01 and 03 (Agriculture and food) with an almost nil contribution of the change in EPR in 03 and 14 (computing equipment).

When looking at other variables, F1 is strongly associated with the numbers of FTAs signed and the share of manufacture in GDP (t: 2.0 and 2.9, respectively) while negatively correlated with domestic primary content in services (t: -3.1) and the share of agriculture in GDP (t:-2.5). F2 is positively correlated with a high domestic primary content in primary exports (t: 2.3) and domestic primary in manufacture exports (t: 2.6) as well as domestic manufacture content in total exports (t: 2.1). Negative partial correlations are observed for the domestic primary content in services (t: -3.1), the stock of FDI (t: -2.3) and export orientation (X/GDP) (t: -2.1) or overall trade intensity ((X+M)/GDP) (t: -2.2). Some countries do not fit well in the overall pattern, especially for Factor 2.

As often in statistics, the interesting information is provided by the indicators that do not follow the expected patterns. In this case, the EPRs of sectors 01 (Agriculture), 03 (Food products), 07 (Fuel products) and 16 (Communication equipment) are not associated with the other MFN EPRs but side together with the effect of preferences. The strong positive association between these EPRs and preferences indicates that high MFN EPRs on those sectors are often found in countries that have active preferential trade policy. This is supported by the second panel of Figure 12, which shows that the EU members (a custom union, one of the deepest preferential agreement) are almost all agglomerated on the right hand side of the graph (Belgium being an outlier here).[22]

Mexico is a clear outlier for this group of countries: it exhibits a relatively high effective protection under MFN but has signed ambitious preferential agreements with its main trade partners. Note that Canada and the USA, despite being part of the same regional trade agreement, are not close

[22] Belgium stands out of the rest of Europe in many trade in value-added analysis. This is due, inter alia, to the specificity of its primary sector (Escaith and Gaudin, 2014).

to Mexico and stands relatively close to the barycentre of the graph, with other non-EU developed economies (low MFN protection, moderate impact of preferences on overall trade). In Latin America, Chile is another example of such policy orientation (albeit applied MFN tariff in Chile are relatively low and with little escalation). Korea, the second supplementary observation, is also identified with this group of countries but lays on the lower side of the graph, in close relation with high MNF EPRs on food and agriculture. Argentina and Brazil, despite being part of a preferential agreement (Mercosur), are clearly identified with the left-hand side of the graph, with high protection and low impact of preferences. This group includes both natural resources rich developing countries (Indonesia, Russia) and labour abundant ones (China, Vietnam).

4.2.2 Beyond Tariff Variables: Incorporating *TiVA* and economic profiles

The objective of this section is to look into more details into the relationship between tariff schedules (either MFN or preferential applied duties) and the *TiVA* profile of the economies. The idea is to progressively gain information on the economic profiles associated with given stales of trade policy. Because the total number of variables to consider is large, the resulting graphs are complex and interpreting them may be difficult. We will only mention here the main results, leaving the details in Annex1.

- **Profiling trade policies on a *TiVA* background**

When only MFN tariffs are considered (See Annex 1, Figure 14 panel a) the underlying patterns are relatively straightforward. The first axis of dissimilarity opposes countries well inserted in GVCs (with a high foreign content in their exports) to more "self-sufficient" economies on the left-hand side (high domestic content in exports). The second factor differentiates countries with a relatively high domestic service component from the natural resources rich countries. Economies that are specializing in primary product tend to have high nominal and effective protection on many of their sectors. A few industries do not follow this pattern. Sector 01 and 03 (Agriculture and Food), 07 (Fuel products) and 14 (Computing equipment) are subjected to moderate protection in the North-East quadrant of vertically specialised countries (i.e., economies that are otherwise open to intermediate imports).

Figure 14, Panel b shows how those MFN results are affected by preferences. The graph opposes the cases where the sectors that registered an increase in their EPR were upstream ones (Mining, Food Agriculture) from countries where the winners were more in industries that are more downstream Paper products, Computing equipment, Electric machinery and Motor vehicles).

By comparing panel (a) and (b) of Figure 14 the most striking result is that while the high MFN nominal and effective protections are concentrated in a single (S-W) quadrant, the winners in preferential agreement are more evenly distributed. In other words, preferential agreements tended to redistribute the protectionist rents across industries and countries. There are exceptions where preferences reinforced acquired protection (Wood products, Communication equipment and Food).

Most developed economies, in particular the smaller ones, are located in the graph regions where vertical specialization is the highest (Luxemburg being an extreme case). But many Asian export-oriented developing economies are also closely associated with this pattern: Singapore, Chinese Taipei, Vietnam, Korea, Malaysia or Hong-Kong. Most of the small economies are regrouped around the barycentre of the graph, meaning that they did not influence much the classification results. The graph will regroup natural-resources oriented countries epitomized by Saudi Arabia and Indonesia. Norway, a European country, is also in this cluster. Another group is made of large G-20 developing countries that have also developed an export-oriented manufacture sector, such as Argentina, Brazil (Russia is also part of this group). Closing the circle by integrating more services while keeping a relatively low vertical integration are the USA and Japan (and also -but in a much lower degree- France and Germany, two large European economies).

To conclude the data exploration, Figure 16 (Annex 1) turns the table and uses tariff variables as the referent for defining principal components and project trade in value-added indicators and other economic variables as supplement. Albeit the procedure seems the symmetric counterpart of

the previous exercise, it will provide additional information by categorizing tariff profiles according to relevant structural economic characteristics.

The interpretation of the resulting graph is quite straightforward. The main factors that are "explaining" the variance observed in the observed trade policies is organized between a North-West quadrant characterized by countries with of high nominal and effective protection. Eastern side will gather observations where preferential trade agreements had a large effect. This North-West / South-East diagonal opposes economies (NW quadrant) that are natural resources rich or are at earlier stages of development (agriculture then manufacture based) to high-income services-oriented countries (SE quadrant). A third group of variables lies on the South and points towards small-open economies (high trade/GDP intensity, strong economic incidence of FDI flows and stock). As noted already in Escaith and Gaudin (2014), economic size does not influence the classification: the variable GDP lies close to the barycenter of the graph and is not associated with any particular profile.

Those results are clearly dominated by the effect of European economies (see Figure 18) which form a compact cluster on the East/South-East quadrant. Only Mexico, far away in a position of outlier in the North-East quadrant, and Chile (member of more than 30 PTAs) join this group of countries strongly influenced by the impact of preferential agreements on their trade policies.

The graph distinguishes natural-resources rich developed countries such as Australia or Norway from the developing ones. Norway, in particular, is an interesting case as it stays close to services-oriented Asian economies like Hong-Kong and Singapore despite being a natural-resources rich country. Another peculiar case is Belgium, who appears very distinct from the other EU members. [23] The West and North-West quadrants are populated with economies where preferences do not play a significant role. Interestedly, Argentina and Brazil, the two main members of the MERCOSUL agreement, sit in this area.

5 CONCLUSIONS

Are tariffs an issue of the past, thanks to the progress in multilateral or regional trade liberalization? Definitely no! Albeit nominal tariffs seem too low to make a difference, the upsurge of global manufacturing and the international fragmentation of Global Value Chains put tariffs back to the front scene as they are cumulated along the supply chain and hence their economic impact is amplified.

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 international competitiveness. At every stage of the global value chain, the value-added contributed by the participating country or firm, is aggregated and embodied within the commercial value of the resulting good or service. Effective protection rates (EPRs) allow analysing the impact of tariffs on the traded value-added by linking the tariff policy with the chain of domestic and international partners for each sector of their respective economies.

The main findings of this paper can be summarised as follows:

- Firstly, measuring trade in value-added reveals the importance of intermediate goods representing more than half of international transactions. Transaction costs (border and behind the border cost of trade) on both imported inputs and exports are a crucial part of the competitiveness of firms and determine in part their ability to participate in production networks. 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 for designing trade and industrial policies. The paper shows for example that mitigating arrangements such as EPZs or draw-back schemes have only limited effects when GVC up-grading is the policy-makers' main objective.

[23] Belgium appears as an outlier (compared to the rest of the EU) in other analysis made by Escaith and Gaudin (2014), in particular for the low incidence of domestic value-added in the exports of natural resources-based products (Belgium is located in the same quadrant than the *TiVA* supplementary variable T_FP --foreign primary content in total exports).

- Secondly, effective protection resulting from MFN tariffs decreased from 1995 to 2008 with developing countries having a sizable number of highly protected sectors, effective protection being usually higher than the nominal one in sectors producing primary and manufactured goods. Developed countries have also high protection in a significant number of sectors, but not primary sectors –mainly raw materials- where EPRs are usually negative.

- Thirdly, trade in value-added highlights the importance of services in international trade and –from a policy perspective– it underlines their role in determining international competitiveness. 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.

- Fourthly, effective protection is negatively correlated with the share of trade in GDP, development level as measured by income and positively associated with natural resources endowment (mining and agriculture). Other structural factors are also determining; for example the smaller and service-oriented an economy, the larger is the weight of its international input procurements in total intermediate consumption and the lower is the effective protection. Even if high effective protection is associated with developing countries 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 as well as in fuels and refined petroleum. The dipole Services orientation vs. Natural resources endowments appears as a strong driver of effective protection policy, even after discarding the strong relationship between a strong services sector and high income/low protection countries. High tariffs were probably set in the past to foster the development of a national industry in natural resources rich countries, following an import-substitution policy. The data show that this policy wasn't successful or, alternatively, that those countries which were successful in applying high protection in the past moved away from protectionism when their domestic industries proved strong enough to sustain international competition.

- Finally, when regrouping countries according to their similarities with respect to tariff policy, European countries, together with Turkey, do form the largest and most homogeneous group. x Korea and Mexico are classified as outliers. The analysis of the impact of trade preferences on effective protection affirms the similarities of EU countries. In other regional trade arrangements, similarities are not that agglomerative. In NAFTA, Mexico exhibits a relatively high MFN protection and high impact of preferential agreements whereas, Canada and the USA, show low MFN protection and moderate impact of preferences on the overall trade. Preferential agreements tend to redistribute the MFN protectionist rents across industries.

More disaggregated results indicate that “Food” and “Agriculture” are the two sectors supporting the highest additional production costs related to duties paid for intermediates For these two sectors, the "MFN-related" additional cost in 2008 of 9.5% and 7%, respectively, and the gains due to preferential schemes is 1 percentage point in average. Textiles, Vehicles and Wood show average MFN duties cost on inputs of around of 5%, with a gain of 1.5 percentage point due to preferences (only 0.6 for Wood). Illustratively, Korea is an outlier for the Food sector, with a MFN cost of 99%, almost duplicating the sectoral production costs relative to international input prices. Norway and Mexico show also relatively high MFN-related additional production costs of 23% and 21% respectively for this sector. Illustratively, large food producers such as Australia or New Zealand seem to apply coherent domestic policies and import duty free all intermediates needed in the Food industries.

Joining an international supply chain offers new industrialisation opportunities for small developing countries. Producing Textiles and Footwear- the usual point of entry for developing countries in global value chains- involves between 2 and 3 different industrial sectors. While firms in Brazil (a large economy) are relatively integrated and source their inputs from the domestic market (only 2 production stages, just 11% being international), China and Vietnam have much longer supply chains. Those are mainly domestic in China (a large economy where 90% of the production stages is domestic) and principally international (55%) in Vietnam. Economies sourcing their processed intermediates abroad are more vulnerable to the cumulative effect of tariff duties on production costs and competitiveness.

Fragmentation and international sourcing depends also of country size for Electrical and optical equipment sector. The sector remains self-centred in the USA, with less than 2 production stages (17% being international). At the contrary, Czech Republic, Thailand and Vietnam rely on international firms for 50% or more of the value chain; Mexico (48% of international segments) is also close to this group of internationally integrated producers that would be vulnerable to a rise of tariffs on their imported inputs or exported outputs.

On the services side, hotels and restaurants experience the highest indirect costs related to duties paid on inputs (6.6% in 2008) with a very low impact of preferences (0.9%) most probably because they source intermediates from the much protected sectors of Food and Agriculture. This may negatively affects the competitiveness of the Tourism sector, one of the most dynamic export sectors of many small developing economies. Construction and Health services incorporate an average cost due to intermediates of 2.2-2.4%. Looking at the country level, Argentina, Mexico, Viet Nam, China and Brazil are in the top-5 list of services' supplier countries with the highest additional duty-related costs in Business services, Computer activities and Renting machinery services.

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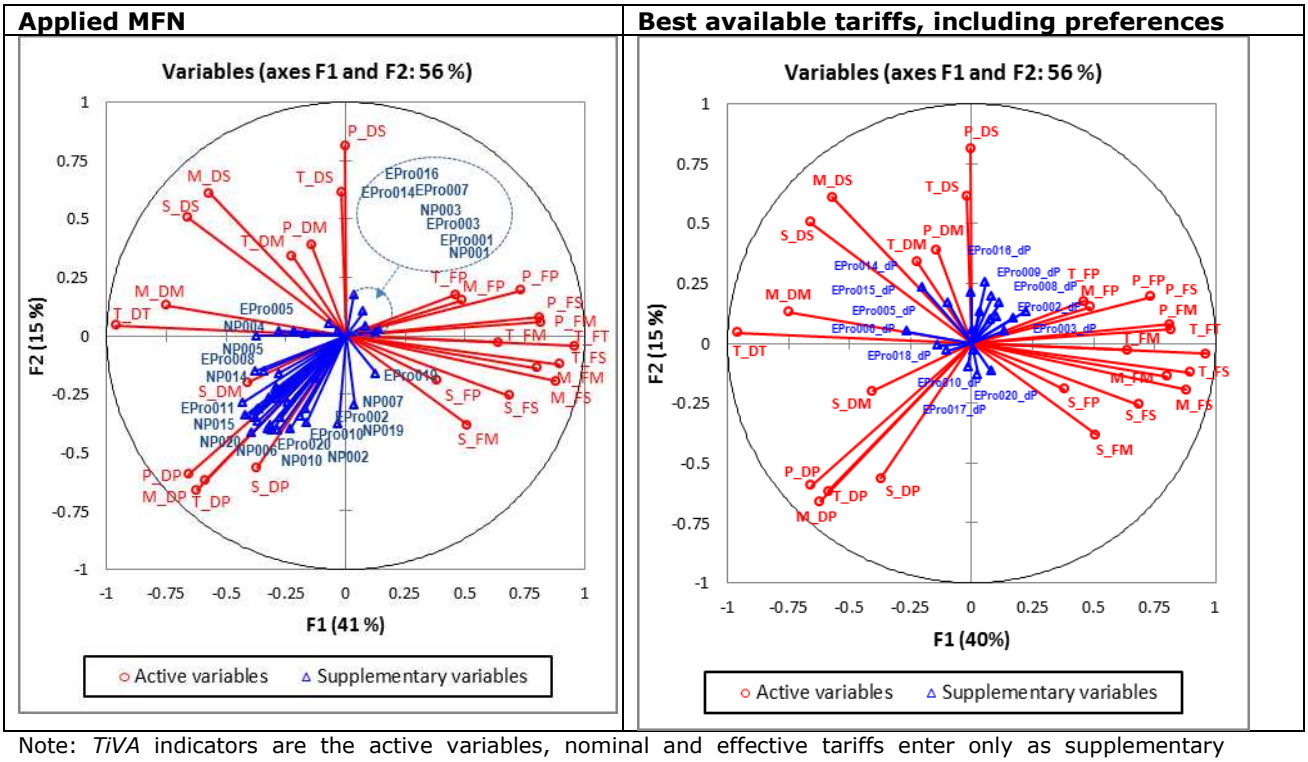
WTO 'World Trade Profiles' http://www.wto.org/english/res_e/statis_e/statis_e.htm

ANNEXES

Annex 1: Principal Component Analysis of Trade, Structural and *TiVA* variables

This section applies PCA using a series of *TiVA* indicators as active variables (those determining the principal components) and nominal and effective protection indicators as supplementary variables. By doing so, the tariff and economic profiles will be projected over the *TiVA* referential, highlighting associations and dissimilarities. The referential, defined by active *TiVA* variables will not change and the interpretation will be based on the relative positioning of supplementary variables in the graph. The set of *TiVA* variables includes the contribution of domestic and foreign value added originating from the primary, secondary and tertiary sectors, into total gross exports, themselves further disaggregated into these three categories.

Figure 14: Projection of tariff profiles over the *TiVA* referential according to the first and second principal component, MFN and Preferences



Note: *TiVA* indicators are the active variables, nominal and effective tariffs enter only as supplementary variables.
Source: Authors' calculation

The first ACP (Figure 14.a) deals only with MNF tariffs. Axis F1 opposes countries well inserted in GVCs on the right (high foreign content in their exports) to more centred economies on the left-hand side (high domestic content in exports). The second axis F2 differentiates on the positive side (North and North-West quadrants) the countries with a relatively high domestic service component from the natural resources rich countries (South-West). South-East quadrant is (loosely) characterised by economies incorporating foreign inputs in their services exports. Economies that are specializing in primary product tend to have high nominal and effective protection on many of their sectors. [24] A few industries do not follow this pattern. Sector 01 and 03 (Agriculture and Food), 07 (Fuel products) and 14 (Computing equipment) are subjected to moderate protection in the North-East quadrant of vertically specialised countries (i.e., economies that are otherwise open to intermediate imports).

Panel b shows how the gains and losses in effective protection due to preferences are distributed. On F1, the positive (East) side is closely associated with countries that registered an increase in the EPR of sectors 02 (Mining), 03 (Food) and 01 (Agriculture). Sector 07 (Fuels) and 08 (Chemicals) are also positively impacted for the countries located in this part of the graph. On the negative (West) side of the axis, we will find cases where the sectors that gained most in effective protection are the 06 (Paper products), 14 (Computing equipment), 11 (Basic metals), 15 (Electric machinery) and 18 (Motor vehicles). In a first approximation, F1 opposes upstream sectors (East) to more downstream ones (West).[25]

On F2, the positive (North) locus is driven by cases of significant EPR gains on many sectors, but in particular (in decreasing order) 16 (Communication equipment), 14 (Computing equipment), 05 (Wood products), 09 (Plastic products), 08 (Chemicals) and 15 (Electrical machinery). The southern side is populated with economies where those same sectors lost but sector 17 (Precision equipment), 10 (Non-metallic mineral products) and 20 (Other manufacture) gained. But the association is much looser than for the North locus.

Comparing panel (a) and (b) of Figure 14 shows that the winners in preferential agreement are more evenly distributed than the highly protected sectors when only MFN is considered. In other words, preferential agreements tended to redistribute the protectionist rents across industries. There are exceptions where, at contrary, preferences reinforced acquired protection. It is the case for 05 (Wood products) in the North-East quadrant and 16 (Communication equipment) and 03 (Food) in the South-East one.

The next projection (Figure 15) matches *TiVA* and tariff patterns on the one hand with countries on the other hand. [26] Not surprisingly, most developed economies, in particular the smaller ones, are located on the right-hand side of F1, where vertical specialization is the highest. Characteristically, the further East-side economy is Luxemburg. But many Asian export-oriented developing economies are also closely associated with this pattern: Singapore, Chinese Taipei, Vietnam, Korea, Malaysia or Hong-Kong. On the North side (positive values of the F2 axis) appear economies incorporating a high content of foreign services imports in their total exports in general. The profile is associated with high effective protection on sectors 03 (Food) and 05 (Wood products). The South locus is occupied by small open economies like Cyprus, Hong-Kong and LVA. Luxemburg is a South-East outlier (high reliance of foreign services in it services exports) and Saudi Arabia a South-West one (high domestic primary content in total exports).

Most of the small economies are regrouped around the barycentre of the graph, meaning that they did not influence much the classification results. Symmetrically, South-West quadrant regroups natural-resources oriented countries epitomized by Saudi Arabia and Indonesia. Norway, a European country, is also in this cluster. Moving northward are large countries that have also developed an export-oriented manufacture sector, such as Argentina, Brazil or Russia. Closing the circle by integrating more services while keeping a relatively low vertical integration are the USA

[24] This may be related to a purely fiscal objective (government revenue) or be related to the relative underdeveloped state of their secondary and tertiary sector. Because EDA does not look into causalities, it is not possible to know if the high protection caused the low development of these activities, or if the high effective protection was put in place in order to improve the value-added content originating from manufacture and services.

[25] The presence of basic metals (upstream industries) in the west part of the graph indicates that this dichotomy is not absolute.

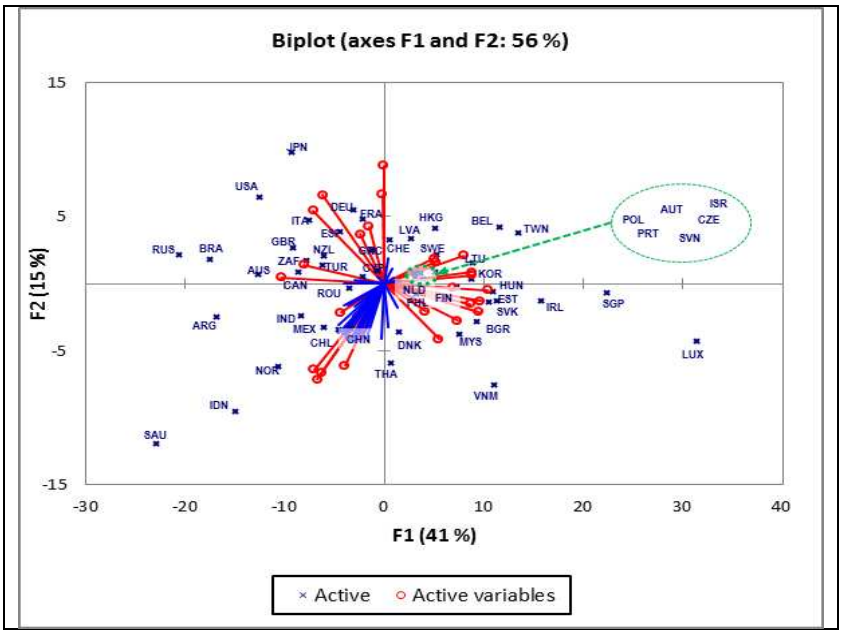
[26] The observations are arranged according to their *TiVA* profile only, because the tariff variables are supplementary.

and Japan (and also -but in a much lower degree- France and Germany, two large European economies).

The countries located on the North-West quadrant entered into preferential agreements that benefited most their sector 14, 15 and 06. On this quadrant are also located large economies such a as Japan, the USA, Brazil and Russia. Closer to the barycentre are large European economies, New Zealand, Turkey, South Africa and Australia.

The North East quadrant, where several sectors gained from the results of preferences, hosts also some smaller European economies, Hong Kong and Israel. Once again, the association between tariffs and countries is always mediated by their association to similar *TiVA* profiles: tariff policy does not directly influence the location of an economy on the graph (this is clear, for example, in the case of Hong Kong where no effective protection can be gained or lost on the basis of MFN or preferences).

Figure 15: Projection of Observations on *TiVA*'s F1 and F2



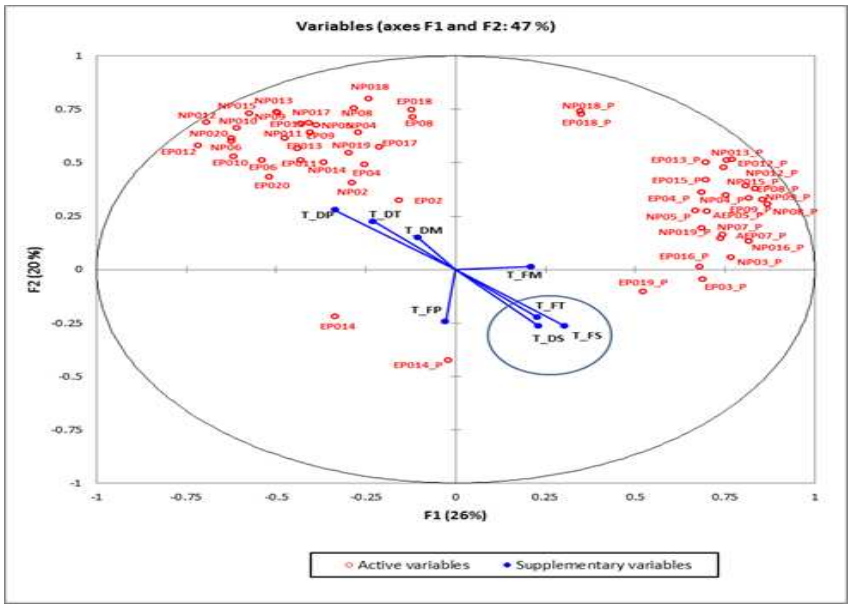
Source: Authors' calculations

- **Profiling *TiVA* and other economic variables on their tariff profiles**

Here, we use the tariff variables as the referent for defining principal components and project trade in value-added indicators and other economic variables as supplement. Albeit the procedure seems the symmetric counterpart of the previous exercise, it provides additional information by categorizing tariff profiles according to relevant structural economic characteristics.

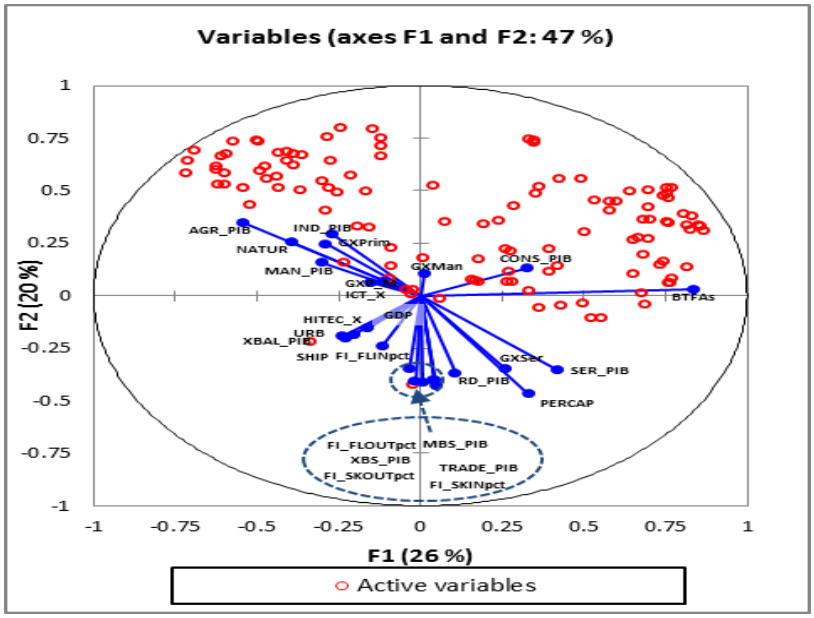
The graph of active variables is organized between a North-West side quadrant of high nominal and effective protection variables. East side is dominated by the effect of preferential trade agreements. North is positively correlated with the nominal and effective protection of only one sector: 014 (Office, accounting & computing machinery).

Figure 16: *TiVA* variables as supplement to a principal component analysis on trade policy variables, 2008



Note: Vertically specialized and service-oriented economies are circled. They are opposed to variables representing economies including in their exports large shares of domestic value-added from primary and manufacturing sectors.
Source: Based on Escaith and Gaudin (2014).

Figure 17: Economic indicators as supplement to a principal component analysis on trade policy variables, 2008



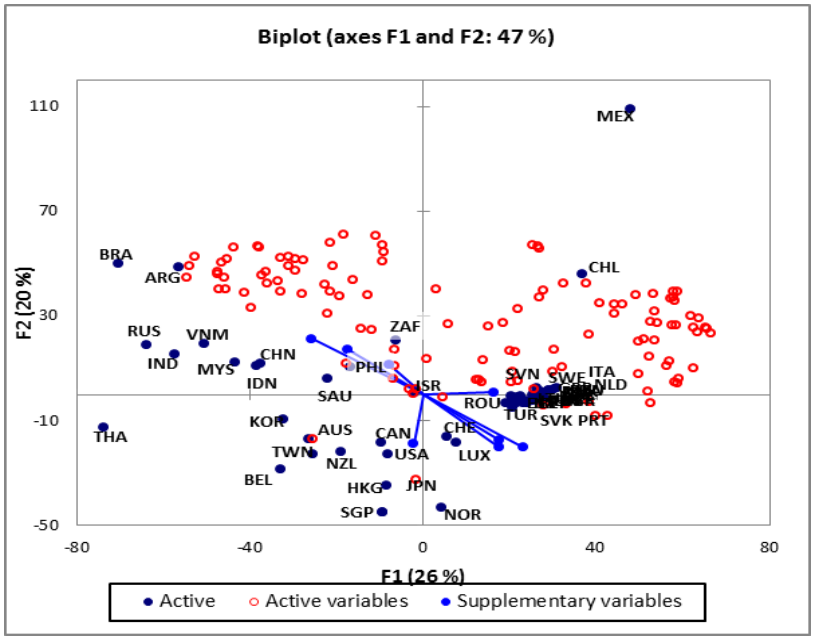
Source: Authors' calculations

Substituting economic indicators to *TIVA* variables as supplementary variables (Figure 17) does not change the calculation of principal components. The main dipole remains the North-West / South-East diagonal, opposing economies (NW quadrant) that are natural resources rich or are at earlier stages of development (agriculture then manufacture based) to high-income services-oriented countries (SE quadrant). Those variables are attracted on the extreme East-side by the indicator representing the number of preferential agreements signed (BTFAs). A third group of variables lies on the South and points towards small-open economies (high trade/GDP intensity, strong economic incidence of FDI flows and stock). As noted already in Escaith and Gaudin (2014),

economic size does not influence the classification: the variable GDP lies close to the barycenter of the graph and is not associated with any particular profile.

When looking at the projection of observations (countries), results in Figure 18, are clearly dominated by the effect of European economies (remember that all EU members share the same external nominal tariff schedule). These countries form a compact cluster on the left-hand side. Only Mexico, far away in a position of outlier in the North-East quadrant, and Chile (member of more than 30 PTAs) join this group of countries strongly influenced by the impact of preferential agreements on their trade policies.

Figure 18: Projection of countries and supplementary *TiVA* variables on the principal components defined by trade policy variables, 2008



Source: Based on Escaith and Gaudin (2014).

Other economies are scattered on the left-hand side. In the North-East quadrant tend to predominate natural-resources rich countries, but there are exceptions (Australia or Norway are on the Southern side of the graph). Norway, in particular, is an interesting case as it stays close to services-oriented Asian economies like Hong-Kong and Singapore despite being a natural-resources rich country. The West and North-West quadrant are populated with economies where preferences do not play a significant role. Curiously, Argentina and Brazil, the two main members of the MERCOSUL agreement, sit in this area.

Annex 2: The Sectors

no	37sectors	ISIC Rev.3
1	Agriculture, hunting, forestry and fishing	1+2+5
2	Mining and quarrying	10--14
3	Food products, beverages and tobacco	15+16
4	Textiles, textile products, leather and footwear	17+18+19
5	Wood and products of wood and cork	20
6	Pulp, paper, paper products, printing and publishing	21+22
7	Coke, refined petroleum products and nuclear fuel	23
8	Chemicals	24
9	Rubber & plastics products	25
10	Other non-metallic mineral products	26
11	Basic metals	27
12	Fabricated metal products, except machinery & equipment	28
13	Machinery & equipment, nec	29
14	Office, accounting & computing machinery	30
15	Electrical machinery & apparatus, nec	31
16	Radio, television & communication equipment	32
17	Medical, precision & optical instruments	33
18	Motor vehicles, trailers & semi-trailers	34
19	Other transport equipment	35
20	Manufacturing nec; recycling (include Furniture)	36-37
21	Utility	40-41
22	Construction	45
23	Wholesale & retail trade; repairs	50-52
24	Hotels & restaurants	55
25	Transport and storage	60-63
26	Post & telecommunications	64
27	Finance & insurance	65-67
28	Real estate activities	70
29	Renting of machinery & equipment	71
30	Computer & related activities	72
31	Research & development	73
32	Other Business Activities	74
33	Public admin. & defence; compulsory social security	75
34	Education	80
35	Health & social work	85
36	Other community, social & personal services	90-93
37	Private households with employed persons	95-99

Source: OECD, http://www.oecd.org/sti/ind/47059256.pdf

Annex 3: The Socio-economic variables

Socio-economic indicators	**Abbreviations**	
Agriculture, value added (% of GDP)	AGR_GDP	
Final consumption expenditure, etc. (% of GDP)	CONS_GDP	
High-technology exports (% of manufactured exports)	HITEC_X	
ICT service exports (% of service exports, BoP)	SER_X	*
Industry, value added (% of GDP)	IND_GDP	
Manufacturing, value added (% of GDP)	MAN_GDP	
Imports of goods and services (% of GDP)	MGS_GDP	
GDP per capita (current US$)	PERCAP_GDP	
Research and development expenditure (% of GDP)	RD_GDP	
Services, etc., value added (% of GDP)	SER_GDP	*
Trade (% of GDP)	TRADE_GDP	

External balance on goods and services (% of GDP)	XBAL_GDP	
Exports of goods and services (% of GDP)	XGS_GDP	
GDP (current US$)	GDP	
Liner shipping connectivity index (maximum value in 2004 = 100)	SHIP	*
Population in urban agglomerations of more than 1 million (% of total population)	URB	
Total natural resources rents (% of GDP)	NATUR	

Source: WDI, World Bank, (* Available only in 2008)

Annex 4: The MFN average protection (nominal and effective) by sector and year

		1995		2000		2008	
Sector	Sector name	NP	EPR	NP	EPR	NP	EPR
001	Agriculture	18.8	24.6	14.3	19.2	9.1	13.5
002	Mining	1.5	0.5	1.4	0.9	0.7	0.2
003	Food	26.0	44.0	17.6	34.9	9.8	17.6
004	Textiles	12.5	20.5	11.2	15.9	10.3	19.5
005	Wood	5.3	3.7	4.7	4.4	3.9	3.3
006	Paper	5.7	8.4	4.1	5.7	2.1	2.5
007	Petroleum	3.3	8.0	3.7	6.1	3.2	12.5
008	Chemicals	6.1	9.1	4.9	8.0	3.2	5.3
009	Plastic	9.2	17.1	8.2	29.9	6.6	13.4
010	Mining Oth	7.3	12.7	6.0	6.4	5.3	10.4
011	Metals	5.5	9.8	4.6	8.4	2.6	3.8
012	MetalPds	6.8	11.5	6.1	10.0	4.8	9.8
013	Machinery	5.0	6.4	3.9	5.2	2.9	4.1
014	Office	4.6	5.3	1.6	-0.6	0.6	-2.1
015	Electrical machinery	6.1	9.2	4.9	8.0	3.8	7.0
016	TVRadio	7.0	11.1	3.2	3.5	2.7	4.2
017	Medical eqt	5.2	6.7	3.2	2.1	2.2	2.9
018	Vehicules	11.9	24.9	11.9	22.4	10.0	23.3
019	Transport Oth	3.6	1.8	2.9	-0.8	3.4	3.5
020	ManufOth	7.5	12.6	5.3	7.6	4.0	5.2
021	Electricity gas water	0.0	-1.9	0.0	-1.4	0.0	-1.3
022	Construction	0.0	-5.1	0.0	-3.5	0.0	-3.4
023	Trade; repair of goods	0.0	-1.7	0.0	-1.2	0.0	-0.7
024	Hotels restaurants	0.0	-7.4	0.0	-6.8	0.0	-4.4
025	Transport, storage	0.0	-1.9	0.0	-1.9	0.0	-1.7
026	Post, telecommunications	0.0	-0.8	0.0	-0.7	0.0	-0.4
027	Finance, insurance	0.0	-0.3	0.0	-0.3	0.0	-0.2
028	Real estate	0.0	-0.8	0.0	-0.2	0.0	-0.2
029	Renting of machinery/equipment	0.0	-1.8	0.0	-1.1	0.0	-0.7
030	Computer activities	0.0	-1.8	0.0	-1.0	0.0	-0.6
031	Research and development	0.0	-2.0	0.0	-1.2	0.0	-0.7
032	Other business activities	0.0	-2.0	0.0	-1.1	0.0	-0.7
033	Public administration, defence	0.0	-1.1	0.0	-1.1	0.0	-0.8
034	Education	0.0	-1.1	0.0	-0.5	0.0	-0.4
035	Health and social work	0.0	-2.5	0.0	-2.2	0.0	-1.1
036	Other community activities	0.0	-1.9	0.0	-2.0	0.0	-0.9
037	Private households	0.0	-1.3	0.0	-2.1	0.0	-0.7

Source: Author's calculation