NTMs in the Presence of Global Value Chains and their Impact on Productivity

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Abstract

In the current globalization process, geographical and local production processes are intertwined through global value chains (GVC). In the presence of GVCs, import tariffs therefore, do not only affect the direct trading partners but also have indirect impact through international industrial linkages. This is also the case for non-tariff measures (NTMs), which have gained importance in the previous decades. The paper analyses effects of such trade policy instruments in the global economy applying a four-stage approach. In the first stage, bilateral import demand elasticities consistent with WIOD classification are estimated. In the second stage, bilateral ad-valorem equivalents (AVE) of four types of NTMs notified to the WTO by the end of 2011 are quantified. Then, cumulative bilateral-trade restrictiveness indices (BRIs) using the AVEs of these NTMs and tariffs taking into account backward linkages are calculated. Finally, in the fourth step the impact of trade policy measures on the average annual growth of labour productivity is assessed.

Keywords: non-tariff measures, global value chains, cumulative ad-valorem equivalents, labour productivity

JEL codes: F13, F14

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1 Introduction

There are certain legitimate motives for the imposition of non-tariff measures (NTMs). When a foreign imported product potentially harms the domestic consumers' health, safety, animal health, environmental quality, etc. countries are allowed to restrict or regulate the importation of that product. Specifically, non-discriminatory standards are regulated across trading partners by qualitative NTMs such as sanitary and phytosanitary measures (SPS), and technical barriers to trade (TBTs) to assure certain standards and characteristics of imported products. Such regulations affect trade flows and prices of products at different stages of production in various ways. For instance, chemicals used in the first stages of production can be the focus of a prohibitive TBT, which can influence the cost of production for downstream products where this product is used as intermediary input. In contrast, some market efficiency regulations such as mandatory labelling set within TBTs can improve the transparent information to the consumers and producers who can utilize the intermediates to their production with lower transaction costs.

The ability of the exporters to comply with such non-discriminatory NTMs differs across countries. It might be the case that certain countries that are already producing in line with the imposed regulations are not harmed or even can increase their exports (due to re-direction effects or a general increase in demand due to quality improvements caused by the NTM). In contrast, some other countries' exports that are not in line with the measures in the destination market might be restricted. The consequence of a specific qualitative NTM might even result in absolute prohibition until the product complies with the implemented standards. Domestic producers in need of intermediate inputs from abroad then alter their demand to those import sources who comply with the new regulations. Therefore, responses of the domestic producers to the NTMs affecting their inputs are heterogeneous across sourcing countries depending on the exporters' capabilities to cope with the standards.

Countries can raise specific trade concerns (STCs) on the TBT and/or SPS imposed by other WTO members. These STCs are mainly raised due to the discrimination or the trade restrictiveness of special cases of TBT or SPS. Some parts of these STCs are already notified by the imposing country to the WTO notifications. However, some STCs are not directly notified by the maintaining member. It is argued that governments sometimes are reluctant to notify their implemented NTMs to avoid trade conflicts, which reduces the transparency of trade policies. Therefore, WTO established TBT and SPS committees to allow member states to discuss the policy measures imposed by other countries. These STCs have certain impact on bilateral trade flows, which sometimes lead to Dispute Settlement cases within the WTO (Ghodsi and Michalek, 2016).

Firms and industries are affected by trade policy measures through three channels. The first channel can be identified as a protectionist measure imposed against the competitors of an industry within the domestic market, which is imposed by the domestic government. The second channel comprises those

measures that the industry faces while exporting to the foreign destinations. The third channel can refer to measures levied against the inputs of production of an industry, which usually imposes extra costs on the intermediate inputs of production in previous stages of production. Depending on the type of measures implemented within each channel, industries are affected differently. Unlike traditional tariffs, some regulatory NTMs might promote trade instead of prohibiting it in any of the three channels. Therefore, some NTMs in the first channel are not necessarily protectionist measures. In addition, in the third channel, those NTMs might reduce the costs of intermediate inputs when they are promoting trade.

Considering global value chains (GVCs), one can track NTMs' traces of the third channel of trade policy (TP) using measures of backward and forward linkages. Diverse impacts of various types of NTMs need to be carefully taken into consideration while studying their role in GVCs. Usually, tariffs and NTMs levied on the first-stage inputs of production exhibit a direct impact on the cost of production. However, heterogeneous effects of NTMs at previous stages of production might affect costs and trade patterns of downstream sectors.

Against this backdrop the paper studies such measures and the way they trickle through GVCs by assessing their role in sectoral performance across forty economies in the world. The main goal of this paper is to study the direct and indirect effects of NTMs through backward and forward linkages within GVCs, and assess their role in the growth of labour productivity of services and non-services sectors. In order to achieve this, the methodological approach is divided into four stages. In the first stage, the bilateral import demand elasticities are estimated. At the second stage, the bilateral impacts of aforementioned types of NTMs on the import flows are assessed allowing one to calculate ad-valorem equivalents (AVE) of the NTMs using the above elasticities. The third stage provides the calculation of bilateral-trade restrictiveness indices (BRIs) that are levied against the upstream input sectors of production for each sector. The fourth stage then analyses the impact of three channels of such measures on the labour productivity growth during the period.

This chapter contributes to the literature by using a comprehensive set of NTMs, calculating import elasticities and AVEs in a bilateral setting and consider the effect of backward and forward linkages of NTMs on labour productivity. The rest of the paper is organized as follows. In the next section we shortly overview the literature on the topic. The third section discusses the first three stages of the methodological approach and the data applied in the analysis. The fourth section presents selected descriptive results. Section five presents the fourth stage of the analysis, i.e. the impact of NTMs on labour productivity growth. Finally, section six concludes.

2 Literature

Already a large number of recent studies exist acknowledging the opaque nature of NTMs. The complex nature of the NTMs is explained by the diversity of the motives of the governments in addition to their various consequences. safety, health, and environmental issues (Otsuki et al., 2001; Ghodsi, 2016) and technological advancement and innovation are the qualitative issues that might have short term hampering impact on trade but a positive long run effect due to positive externalities (Beghin et al., 2012). Additionally, substitutability for tariffs (Moore and Zanardi, 2011; Ghodsi, 2016), substitutability for other NTMs (Rosendorff, 1996), and policy retaliation (Vandenbussche and Zanardi, 2008; de Almeida et al., 2012) are political motives behind the imposition of NTMs that might lead to trade disturbances and prohibitions. The various causes of NTMs left no solid consensus for the general impact of each type of NTM among scholars. Hence, it might be more appropriate to analyse the causes and effects of each measure separately instead of giving a general conclusion regarding the diverse effect of NTMs given their complexity and ambiguous effects.

A common way to assess the impact of NTMs is to calculate ad-valorem equivalents. The estimation of the ad-valorem equivalent (AVE) for NTMs has been first proposed by Kee et al. (2009) using cross sectional trade data at the 6-digit level of the Harmonized System (HS) for 2002. They constrained their results to only the positive AVEs thus assuming at hampering effect on trade. This approach was then applied by Beghin et al. (2014) and Bratt (2014), however, allowing for negative AVEs representing promotive behaviour of the NTM as well. In these studies however all various types of NTMs were included as a single dummy variable indicating whether any type of NTM impacted on the respective trade flow. Moreover, the estimates at the product level provided only one (average) estimator of the impact of NTMs across all countries. The unilateral elasticities used in those studies were borrowed from Kee et al. (2008), which by construction vary across countries only through variations of the share of import in GDP of the product under consideration across countries. The shortcoming of those approaches is that the impact of the imposed NTMs by various countries on a single product is assumed to be uniform and is captured by a single estimator. Ghodsi et al. (2016a) extend the approach allowing the impacts of NTMs to vary by the importing countries. In this paper, we extend this empirical strategy differentiating the impact of NTMs by types, by products, by the imposing country, and by the exporting country facing them.

The second building block of our approach is the concept of global value chains (GVC). During the 1980s in a research proposal on *the modern world system*, Hopkins and Wallerstein (1977) elaborated the concept of *commodity chains* in a macro and holistic perspective as whatsoever inputs that a final consumable good needs to reach the final consumer. The process in which any types of raw materials, services, transportation mechanisms, or even food inputs consumed by the labour at any stages of production of all inputs used for an ultimate consumable item was termed as *commodity chains*. Later on, Gereffi (1994) established a study framework on *global commodity chains* (GCC) in a meso or

micro perspective. Industrial organization and structural governance in the economic literature of international business discussed in various studies such as Porter (1985) shifted the concept towards the GVC, which is not conceptually far from GCC. Studies such as Gereffi et al. (2005), and Gereffi and Sturgeon (2013) however, use GVC in explaining the industrial characteristics and performances through inter-firm and inter-industry relations.[1]

Trade liberalization, decreasing tariff rates and reduction of other trade barriers forced by international and multilateral agreements lead to an increasingly important role of GVCs in the world economy. Moreover, existing offshoring strategies, outsourcing of activities and global fragmentation of production of goods and services are emerging due to the reduced transaction costs by technological development in recent decades, such as the improvement in the information and telecommunication (ICT) services. In fact, ICT services advancement replaced the traditional transport costs, which are also parts of the GVC as major services sectors (Backer and Miroudot, 2013).

The importance of GVC was emphasized more recently in efforts compiling inter-country input-output databases such as the World Input-Output Databases (WIOD) by Timmer et al. (2012). Many scholars have proposed and used frameworks to track the GVC through WIOD. Antràs et al. (2012) establishes a framework to calculate upstreamness of sectors as the stages of production within GVCs to the ultimate consumable item. Using the same methodology and considering the whole world as a single economy, Chor et al. (2014) and Miller and Temurshoev (2015) find that upstreamness across countries has increased due to liberalization in trade. Backer and Miroudot (2013) also show that number of stages within the GVC has increased during 1995-2008, which indicates a dominant role of trade liberalization in global fragmentation of production. This further implies that services and manufacturing are more intertwined, and their shares of value-added in each other's value-added are becoming increasingly important in the globalization process (OECD, 2013).

The intertwined sectors within GVC can be referred as a network of industries, in which a simple shock in one are reflected in further effects along GVCs. Considering tariffs as a policy shock to a specific sector, all users of that sector are affected along the GVC. Rouzet and Miroudot (2013) proposed a framework to calculate the cumulative effect of such a shock. In fact, their approach calculates the cumulative costs of tariffs against the inputs of a given sector. Miroudot et al. (2013) use the same methodology to estimate the cumulative tariffs on the inputs of services sectors. In fact, they track the effects of tariffs against non-services industries on the production and exports of services. They find a downward trend of cumulative tariffs on services sectors for majority of countries from 2000 to 2009 due to liberalization through WTO commitments.

Thirdly, the relationship between productivity growth and trade openness is also widely studied in the literature (e.g. Harrison, 1996; Edwards, 1998; Frankel and Romer, 1999; Rodriguez and Rodrik,

[1] For further study on the conceptual evolution of GVC, see Bair (2005).

2001). Grossman and Helpman (1993) argue that diffusion of knowledge through the inputs of production traded to a country increases the innovative capacities and consequently productivity. Coe, Helpman, and Hoffmaister (1997) identify channels through which R&D spillovers affect productivity. Among those channels, imports of intermediate inputs and capital goods transfer the embodied technology of products produced in a country to another affecting the productivity of the producers in the destination. In addition to this direct link, other scholars found such technology spillovers from a third country in the middle of the supply chain. Lumenga-Neso et al. (2005) find an evidence of such an indirect effect of technology spillover from a country to another country that have no trade relationship on the given sector. Thus, similar to tariff shocks discussed above, it would be possible to have the effects of technology shocks along GVCs. Nishioka and Ripoll (2012) tested the direct and indirect effects of technology spillovers through intermediate inputs using input-output tables. Using WIOD, Foster-McGregor et al. (2014) find a positive relationship between the growth of the R&D contents of the intermediate inputs and labour productivity growth.

Going through the selected studies within the literature there are still some gaps to be filled. Specifically, despite the existing studies on the effects of cumulative tariffs using the backward linkages, the literature still lacks the measurement of NTM impacts along GVCs. This contribution aims at filling this gap by discussing the impact of NTMs along global value chains on productivity.

3 Methodology

As already sketched in the introduction the methodological approach followed in this paper consists of four stages, three of which will be elaborated in the following sub-sections, and the fourth stage will be presented in Section 5.

The methodological contributions of this paper to the literature summarised above are: In the first step is to provide bilateral import demand elasticities which is an extension to previous unilateral demand elasticities provided by Kee et al. (2008) and which is calculated for a more recent period from 2002 to 2011. Second, based on this we provide new ad-valorem equivalents (AVE) for four types of NTMs capturing the effects of these policy measures' intensity varying across sectors, importers, and exporters during the period. Third, taking externalities associated with some NTMs in addition to their trade restrictiveness into account, we provide cumulative AVEs summed up to a bilateral-trade restrictiveness indices (BRI) levied on the inputs of industrial production. Fourth, having these measures, we assess the impact of encompassing trade policy measures on the growth of labour productivity consistent with the WIOD classification (which is reported in Section 5).

3.1 Bilateral import demand elasticities

In order to calculate AVEs characterising the impact of NTMs on the quantity of the imported products, one needs to estimate the respective import demand elasticities. These import demand elasticities determine how much a one-percentage variation in the price of the imported product changes the quantity of the imported product in percentage. Such import demand elasticities were estimated by Kee et al. (2008) for the period 1988-2002, which however assumed to be unilateral across countries. In contrast, this analysis considers bilateral trade flows at the level of Harmonized System (HS) 6-digit products over the period 2002-2011. In doing so, we extend the approach proposed by Kee et al. (2008) allowing for bilateral estimates of elasticities. Starting from a flexible GDP function including prices of imported products differentiated by the country of origin *j* and factors of production one can extend the GDP function into a semi-flexible function including only one price indicator for the estimation. This price indicator is a ratio of the price of the imported good *h* in country *i* from country *j*, relative to the average price of all other goods demanded in the GDP of country *i*. Hence, the resulting benchmark equation to be estimated by product-exporter *hj* is as follows:

$$s_{hij}^t\left(p_{hij}^t, p_{-hi}^t, v_{hi}^t\right) = a_{0h} + a_{hij} + a_h^t + a_{hhj}^t \ln\frac{p_{hij}^t}{p_{-hi}^t} + \sum_{m\neq l, m=1}^{M} c_{hm}^t \ln\frac{v_{mi}^t}{v_{li}^t} + u_{hij}^t,$$
$$\forall h = 1,\dots,H, \qquad \forall i = 1,\dots,I, \qquad \forall j = 1,\dots,J, \tag{1}$$
$$\kappa_{hij}^t = a_{hi} + a_h^t + a_{hj} + u_{hi}^t$$

where s_{hij}^t is the share of value of product *h* shipped from country *j* to country *i* in the GDP of the country *i* at time *t*; p_{hij}^t is the price (unit value) of the imported product; v_{mi}^t and v_{li}^t refer to the factors *m* and *l* in the production of GDP of country *i*; and p_{-hi}^t is the Tornqvist price index (Caves et al., 1982) of all other goods constructed using the GDP deflator p^t as follows:

$$\ln p_{-h}^t = \left(\ln p^t - \bar{s}_h^t \ln p_h^t\right) \Big/ \left(1 - \bar{s}_h^t\right), \qquad \bar{s}_h^t = \left(\bar{s}_h^t + \bar{s}_h^{t-1}\right) \Big/ 2 \tag{2}$$

However, estimating equation (1) by each product-exporter pair would reduce the consistency of the estimates due to small number of observations, which vary only across importing countries. In order to increase the efficiency of the estimates, estimation can be run by each product. In order to differentiate the countries of origins this requires to the interaction of the price indicator $\frac{p_{hij}^t}{p_{-hi}^t}$ with the exporter dummies. Thus, equation (1) is transformed into the following equation:

$$
\begin{aligned}
& s_{hij}^{t}\left(p_{hij}^{t}, p_{-hi}^{t}, v_{hi}^{t}\right) \\
& \quad = a_{0h} + a_{hij} + a_{h}^{t} + \sum_{j=1}^{J} a_{hhj} \ln \frac{p_{hij}^{t}}{p_{-hi}^{t}} a_{hj} + \sum_{m \neq l, m=1}^{M} c_{nm}^{t} \ln \frac{v_{mi}^{t}}{v_{li}^{t}} + u_{hij}^{t}, \\
& \quad \forall h = 1, \ldots, H, \qquad \forall i = 1, \ldots, I, \qquad \forall j = 1, \ldots, J, \\
& \quad \kappa_{hij}^{t} = a_{hi} + a_{h}^{t} + a_{hj} + u_{hi}^{t}
\end{aligned}
\tag{3}
$$

For the purpose of the calculation of accumulated AVEs at a level allowing one to assess the effects of backward and forward linkages, we are bound to use the WIOD industry classification in our analysis. Assuming homogeneous functional forms of parameters for the HS 6-digit products within each WIOD category, and controlling for their heterogeneity using the country-pair product fixed effects (FE) κ_{hij}^{t}, we estimate equation (3) for each WIOD industry encompassing all 6-digit products via the relevant concordance tables. This firstly gives us a large number of observations with a larger number of statistically significant estimators. Secondly, capturing the variations across products it controls for cross-price elasticities within each WIOD category. Therefore, parameters a_{hhj} – as many as the number of exporters *J* – are estimated for each sector. Kee et al. (2008) suggested another method to calculate elasticities of sectorial levels using the elasticities at disaggregated levels[2]. By construction, the share of imports in GDP is negative, which gives the import demand elasticity of good *hj* derived from its GDP maximizing demand function as follows:

$$
\hat{\varepsilon}_{hhij} \equiv \frac{\partial q_{hij}^{t}(p^{t}, v^{t})}{\partial p_{hij}^{t}} \frac{p_{hij}^{t}}{q_{hij}^{t}} = \frac{\hat{a}_{hhj}}{\bar{s}_{hij}} + \bar{s}_{hij} - 1, \qquad s_{hij}^{t} < 0; , \qquad \varepsilon_{hhij}^{t} \begin{cases} < -1 \; if \; a_{hhj}^{t} > 0 \\ = -1 \; if \; a_{hhj}^{t} = 0 \\ > -1 \; if \; a_{hhj}^{t} < 0 \end{cases} \tag{4}
$$

3.2 AVE for NTMs

In the second step we use a gravity framework to estimate the impact of four types of NTMs on the bilateral import quantity extending the approach proposed by Kee et al. (2009)[3] as outlined in Section 2. The estimated specification is,.

$$
\begin{aligned}
\ln\left(q_{ijht}\right) = \; & \alpha_{1h} + \sum_{k} \alpha_{1k} C_{ijt}^{k} + \alpha_{1ht} \ln\left(1 + T_{ijht}\right) + \sum_{ij=1}^{IJ} \sum_{n=1}^{N} \omega_{ij} \beta_{1nh} NTM_{nijht} + \omega_{1ijh} + \omega_{1t} + \mu_{1ijht} \; , \\
& \forall n \in \{SPS, TBT, TBT\ STC, SPS\ STC\}
\end{aligned}
\tag{5}
$$

where $\ln\left(q_{ijht}\right)$ is the natural logarithm of the import quantity of product h to country i from country j at time t; C_{ijt}^{k} is the country-pair characteristics and consists of classical gravity variables and factor

[2] Such sectorial aggregates of elasticities can be provided upon request.
[3] This approach has been extended by Ghodsi et al. (2016a) differentiating NTM types and importers.

endowments. It includes traditional market potential of trade partners that is the summation of both countries' GDP:

$$Y_{ijt} = \ln(GDP_{it} + GDP_{jt}) \tag{6}$$

and the economic development distance similarly used by Baltagi et al. (2003):

$$y_{ijt} = \left(\frac{GDPpc_{it}^2}{(GDPpc_{it} + GDPpc_{jt})^2} + \frac{GDPpc_{jt}^2}{(GDPpc_{it} + GDPpc_{jt})^2}\right) - \frac{1}{2}, y_{ijt} \in (0, 0.5) \tag{7}$$

In addition, C_{ijt}^k includes distance between the trading partners in three relative factor endowments: labour force L, the capital stock K, and agricultural land area A_l as follows:

$$f_{çijt} = ln\left(\frac{F_{çjt}}{GDP_{jt}}\right) - ln\left(\frac{F_{çit}}{GDP_{it}}\right), F_ç \in \{L, K, A_l\} \tag{8}$$

Further variables that enter our regressions are dummy variables indicating whether both trade partners are EU or WTO members, or having a Preferential Trade Agreement (PTA)[4]. ω_{1ijh} and ω_{1t} are respectively country-pair-product and time fixed effects capturing multi-resistances. Similar to the estimation of elasticities, the estimations are run at the WIOD industry level encompassing all corresponded 6-digit products of the HS. In order to achieve unbiased estimators robust to heteroscedasticity, we cluster the variance-covariance vectors of the error terms μ_{1ijht} by the country-pair-products.

Equation (5) incorporates the coefficients capturing the impacts of tariffs α_{1ht} and non-tariff measures on imports $\omega_{ij}\beta_{1nh}$, which in a final step are transformed to AVEs. For tariffs T_{ijht} we prioritize the data on AVEs (using UNCTAD 1 methodology[5]) on preferential tariff rates (PRF), then AVEs on most favoured nation rates (MFN), and then effectively applied rates (AHS). NTM_{nijht} are count variables for four different groups of NTMs, i.e. $\forall n \in \{SPS, TBT, TBT\ STC, SPS\ STC\}$. For instance, $NTM_{TBTijht}$ shows the number of TBTs in force at time *t* (since beginning) maintained by country *i* on product *h* against trade partner *j*. This in fact is one of the major contributions of this paper capturing the intensity of each type of NTM. In order to obtain bilateral-product-specific AVEs of NTMs, we interact NTM variables with country-pair dummies ω_{ij}. However, including all country-pair interactions with all NTMs would exhaust all degrees of freedom. Therefore, we run the regression four times (for each NTM type) for each sector. Each time one of the NTMs is interacted with the bilateral dummy whereas the rest of the NTMs are kept as control variables.

[4] We could use other gravity variables such as distance, contiguity, common languages, common colonial history, and same countries in the regressions. However, using the country-pair product fixed effects would drop out these time-invariant variables.
[5] UNCTAD/WTO (2012)

In a last step, we consider all coefficients of NTMs ($\omega_{ij}\beta_{2nh}$) to derive their corresponding AVEs. For this purpose, bilateral import demand elasticities ε_{ijh} from the previous stage are used. AVEs are obtained by differentiating import equation (5) with respect to each of the count variables for NTMs:

$$ave_{nijh} = \frac{1}{\varepsilon_{ijh}} \frac{\partial \ln(q_{ijh})}{\partial NTM_{ijh}} = \frac{e^{\omega_{ij}\beta_{1nh}} - 1}{\varepsilon_{ijh}} \tag{9}$$

Summarising, as discussed earlier, this approach improves the estimates of the impact of NTMs and the calculations of AVEs compared to previous studies by additional information on the intensity of various types of NTMs. The reason for this is that variations in ave_{nijh} are not only due to the variations in the imports share to GDP across countries within the estimated bilateral-import demand elasticities, but also by the variations in the diverse effect of each NTM imposed against a specific trade partner.

After estimation of AVEs for each type of NTM, we calculate the bilateral restrictiveness index (BRI_{ijh}) as the summation of AVE for all trade policy measures τ (i.e. all NTMs and weighted average tariff during 2002-2011) imposed by country *i* against product *h* imported from country *j*.

$$\overline{BRI_{\imath jh}} = \sum_{\tau} \overline{ave_{\tau\imath jh}} \quad , \qquad \tau \in \{T, SPS, TBT, TBT\ STC, SPS\ STC\} \tag{10}$$

where $\overline{ave_{\tau\imath jh}}$ stands for the period averaged AVEs. The estimation on equation (5) results in the average impact of NTMs during the period as AVEs. To have a consistent measurement of BRI for the period, we take the average of AVE for annual tariffs over the period and use it in equation (10).

3.3 Cumulative AVEs in GVCs

Following Miroudot et al. (2013) the cumulative AVEs of NTMs and tariffs along GVCs can then be tracked. For notational convenience, denote the various types of AVEs calculated in the previous stage for the period 2002-2011 by τ_{ijh}. Each industry *h* in a given country *i* is influenced by three channels.

The **first channel** of trade policy is comprised of the direct trade policies (τ_{1ijh}) that the government of country i imposes on imports of industry h from country j. Traditional tariffs and prohibitive NTMs with positive AVEs are often implemented to support the domestic industry producing this product h. In fact, these measures protect the domestic industry by reducing the fierce competition. This is expected to reduce imports of these products. However, some qualitative NTMs with negative AVEs stimulate imports of products increasing the competition in the domestic market. When country *i* imposes a tariff τ on a specific product *h* imported from country *j*, domestic production of the sector producing this product might benefit from the direct τ_{1ijh} as the price of the imported product increases by τ_{1ijh}, while consumers lose (due to higher prices). However, as this sector – given the level of

aggregation in the data – also sources these products from abroad ('narrow offshoring') it also faces higher costs making the sector less competitive (depending on the cost share of the imported product).

The **second channel** includes the trade policy measures that an industry h in country i is facing while exporting to other destinations j, i.e. by trade policy of the export destination country j against products of industry h from country i (τ_{2ijh}). According to the 'new new trade theories', the relatively more productive firms can be able to afford higher costs of exports incurred by tariffs or qualitative regulations, which therefore lead to higher productivity at the industry level.

Finally, the **third channel** affects the intermediate inputs of a given industry h', which is captured by indirect trade policy measures τ_{3ijh} (named BRI_3 for aggregate trade policy measures). Trade policies in country i against imports of product h (from country j) affect the industries h' using product h in their production process (as intermediate input). Like a tariff, this might result in higher costs for the industries using this product intensively (even including industry h itself). However, depending on the type of trade policy tool in this channel, a given industry h' can be affected diversely because a trade policy measure might affect the quality of imports, thus, increasing both the costs and quality of the inputs along backward linkages of GVC.

Further, there is an indirect effect on the respective downstream industries $h' \neq h$ which (indirectly) use the importing products from other sectors h' as intermediate inputs for sector h, as these also bear costs from the $\tau_{1ijh'}$. Thus, the impact of the indirect *cumulative* $\tau_{1ijh'}$ is reflected as costs along later stages of production utilizing the affected sectors' output as inputs.

In order to calculate τ_{3ih} we follow Miroudot et al. (2013). The amount τ paid for the trade policies in the production of one unit of good *h* in country *j* is $\sum_{ks} a_{ksjh}\tau_{jks}$, where $a_{ks,jh}$ denotes the technical coefficient of the sector *s* from country *k* that is used in the production of sector *h* in country *j* as input, and τ_{jks} is the imposed trade policy τ by country *j* on the import of industry *s* from country *k*. Going one stage further backward, one needs to take into consideration the τ imposed on the inputs of the above calculated stage as $\sum_{xz}\sum_{ks} a_{ksjh}\tau_{jks}\, a_{xzks}\tau_{kxz}$, where a_{xzks} is the amount of sector *z* from country *x* used in the production of sector *s* in country *k*. Adding up all other imposed τ at previous stages of production, one obtains the required measure of Iτ. Using matrix algebra, this measure can be summarised as follows:

$$\tau_3 = \left[e \times B \times \sum_{n=0} A^n\right]' = [e \times B \times [I - A]^{-1}]' \qquad (11)$$

where A^n is a J by J matrix of technical coefficients, e is a row vector of ones, B is a J by J matrix of element-by-element multiplication of technical coefficients and τ; $B = A{:}\times\tau$. At the end, τ_3 is a column vector indicating the τ_3 for the inputs of production of each country-sector. Technical coefficients are calculated using the Leontief inverse based on the world input-output tables (WIOT).

The AVEs calculated in the previous stage are for the period 2002-2011, which indicate the impact of NTMs over time. Therefore, in order to have τ_3 over the whole period, the average of technical coefficients over the period, i.e. $A = \frac{1}{10} \times \sum_{t=2002}^{2011} A_t$ is used. As mentioned above, for bilateral tariffs, we use the import weighted average bilateral tariffs during the period.

3.4 Data

At the heart of the dataset is the WTO I-TIP notifications database on NTMs as documented in Ghodsi et al. (2016b). Import data for all WIOD economies except Taiwan as the importing country were taken from the UN COMTRADE database and complemented by the TRAINS database. Thus, the data for the rest of the world (ROW) is the aggregation of all other economies in the world. We consider AVEs of tariffs at the HS 6-digit level from TRAINS. Wherever AVEs for tariffs are not available, preferential tariff rates (PRF), most-favoured nation tariff rates (MFN), and effectively applied rates (AHS) are included in respective orders. These data are corresponded to WIOD classification using relevant concordance tables. It is important to note that for the intra-EU trade, tariffs and NTMs are set to zero reflecting the common trade policy within the EU. This allows to keep the trade observations between the EU members.

Data on factor endowments (labour force, capital stock) as well as GDP are retrieved from the Penn World Tables (PWT 8.1); see Feenstra et al. (2013 and 2015). The latest update of the PWT includes data for 2011, which constrains the AVEs for NTMs to the period 2002 to 2011. Output-side real GDP per capita at chained PPP in 2005 USD are used for the computation of the similarity index, while expenditure-side real GDP at chained PPP in 2005 USD was considered for representing the traditional market (demand) potential. Information on agricultural land was taken from the WDI of the World Bank and wherever not available is obtained from Food and Agriculture Organization of the United Nations Statistics (FAOSTAT)[6]. CEPII provides data on commonly used gravity variables as mentioned above. As stated above, technical coefficients are calculated using the inverse Leontief of the WIOD.

4 Selected descriptive results

Let us recapitulate. Our analysis results in several datasets for the period 2002-2011. First, we provide a dataset on bilateral import demand elasticities estimated at each WIOD industry including all corresponding HS 6-digit products. Second, by estimating the AVE for NTMs, we have a dataset of direct bilateral AVE for four types of NTMs imposed against 6-digit products within each WIOD industry level imported to a country (τ_{ijh}). Moreover, the summation of all AVEs and average tariffs within each WIOD industry gives a dataset on BRI_{1ijh} and/or BRI_{2ijh}. Third, using the matrix algebra, we construct a dataset of τ_{3ih} and BRI_{3ih} indicating the restrictiveness of a trade policy measure τ on

[6] Can be found here: http://faostat.fao.org/site/377/DesktopDefault.aspx?PageID=377#ancor

trade of the inputs to a specific country-sector within WIOD classification. Of course, summing up all τ_{3ih} for a given industry h in country i (similar to equation 10) gives the aggregate bilateral restrictiveness index on the inputs of production in the focal country-industry (BRI_{3ih}). Such a dataset is constructed on the AVE for each type of NTM affecting the trade of inputs of production during the period. The elasticity and direct AVE datasets are available for only manufacturing industries. Indirect restrictiveness indices dataset is compiled for both services and non-services WIOD sectors using the input-output linkages.

Table 1 – Direct AVE statistics – first channel

NTM	Sample Mean	Mean AVE>0	No. AVE>0	Mean AVE<0	No. AVE<0
SPS	0.061%	11.632%	2653	-11.126%	2629
SPS STC	-0.060%	15.000%	399	-23.330%	324
TBT	0.205%	10.461%	3526	-9.290%	3391
TBT STC	0.039%	11.912%	1033	-12.658%	892

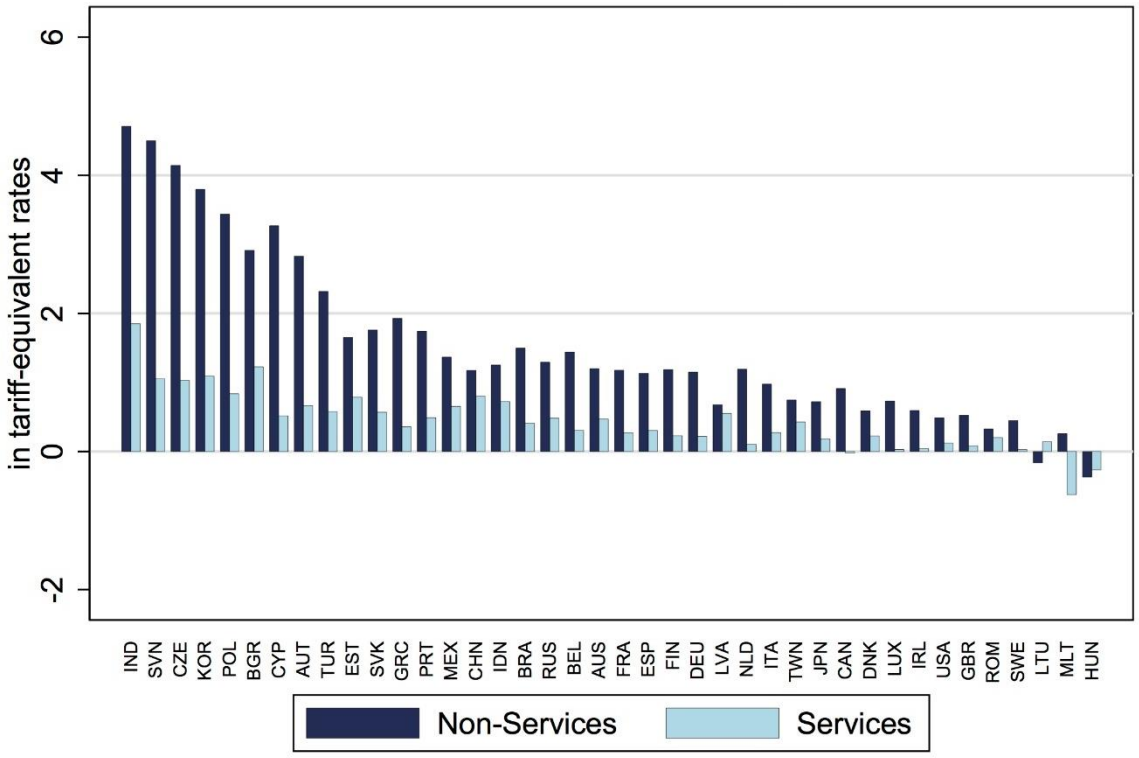
Source: wiiw calculations.

In the following, only the estimation results that are statistically significant at 10% level are included in the analysis. It is important to note that the AVEs are not constrained to only positive ones indicating restrictiveness, and positive elasticities are not dropped out. This means that for some bilateral flows, some NTMs promoted trade resulting in negative AVE. Besides, AVEs are constrained to 100 in absolute terms. The intuition behind is that an NTM that works as a subsidy rather than a tariff cannot reduce the price of a given imported product by more than 100%.

Table 1 shows a summary statistics of the direct AVEs (first channel). Both positive and negative AVEs are included. For instance, TBT in average works as a tariff of 0.21%, while there are 3526 positive AVEs for TBTs with the magnitude average of a 10.46% tariff, and there is 3391 negative AVE for TBTs with the average subsidy-equivalent of 9.29%.

Next, we present the indirect bilateral restrictiveness indices (BRI_3) levied against the inputs of production along the GVC showing ad-valorem restrictiveness of all NTMs and tariffs in percentages of export values. These results are country aggregates using simple averages over all sectors. In the appendix the τ_3 for each of the four types of NTM considered in this paper on the inputs of production are presented by country.

Figure 1 – Country Average IBRI – third channel



Source: wiiw calculations; sorted by average BRI_3 across all sectors

Figure 1 indicates that these BRI_3s for manufacturing sectors range from -0.37% for Hungary to 4.7% for India as tariff-equivalent rates and are generally larger for manufacturing industries as compared to services industries which are affected only indirectly. The highest BRI_3s in manufacturing are for India (4.7%), Slovenia (4.5%), Czech Republic (4.14%), Korea (3.8%), and Poland (3.43%).

Despite positive indirect accumulative tariffs on inputs (see Figure 2 in the Appendix) the average BRI_3s are negative for two countries (Figure 1). Hungary and Lithuania on average benefit from their trade policy measures with average negative BRI_3s including AVEs from both tariffs and NTMs. This suggests that producers in these countries benefit from trade policies which promote the trade of their inputs of production along the GVC. This happens for both Hungarian services and non-services sectors. In fact, BRI_3 for the intermediate inputs of Hungarian services is equivalent to -0.27% tariff. On the other hand, Indian suppliers incur larger losses for more expensive inputs of all sectors due to trade restrictive policies. While normal tariffs induce around 2% indirect tariffs (Figure 2 in the appendix) to the Indian inputs for manufacturing sectors tariffs accumulated along previous stages of GVC incur 0.85% for the inputs of Indian services sectors. This suggest that NTMs induce around 2.7% to non-services Indian sectors in average, which in total make the average BRI_3 on Indian inputs to 4.7%. Accumulated impact of global NTMs on the inputs of Indian services sector is thus around 1%.

As mentioned above, no tariffs are levied against trade flows of services. However, service providers are indirectly affected by the policy measures imposed against the non-services inputs for their production. In general, services are less impacted due to no direct impacts and the lower linkages. For few economies, service inputs are promoted on average by the global trade policy measures while the inputs for the manufacturing have become expensive due to such measures. BRI_3 of all trade policy measures on services in the rest of the world economy (RoW) is -4% while on manufacturing it is about 2.5%. Malta and Canada are also enjoying negative IBRI for their services sectors while facing a positive accumulated cost on the inputs of their manufacturing production.

Table 2 –Third channel of trade policy measures by type, Global simple average by WIOD sector

Sector	Sector Description	BRI	Tariffs	SPS	TBT	TBT STC	SPS STC
1	Agriculture, Hunting, Forestry and Fishing	0.66%	0.54%	0.15%	0.00%	0.11%	-0.14%
2	Mining and Quarrying	0.76%	0.27%	0.45%	-0.07%	0.12%	0.00%
3	Food, Beverages and Tobacco	0.97%	1.08%	0.05%	0.05%	0.11%	-0.31%
4	Textiles and Textile Products	2.18%	1.02%	0.83%	0.38%	0.00%	-0.06%
5	Leather, Leather and Footwear	1.29%	1.04%	0.43%	0.05%	0.09%	-0.32%
6	Wood and Products of Wood and Cork	0.91%	0.82%	0.06%	0.19%	0.06%	-0.22%
7	Pulp, Paper, Paper , Printing and Publishing	0.69%	0.50%	-0.07%	0.24%	0.04%	-0.01%
8	Coke, Refined Petroleum and Nuclear Fuel	2.91%	0.56%	2.25%	-0.22%	0.33%	-0.02%
9	Chemicals and Chemical Products	1.50%	0.62%	0.48%	-0.03%	0.28%	0.14%
10	Rubber and Plastics	1.81%	0.76%	0.42%	0.18%	0.32%	0.14%
11	Other Non-Metallic Mineral	1.05%	0.41%	0.53%	0.01%	0.10%	0.01%
12	Basic Metals and Fabricated Metal	3.21%	0.62%	2.06%	0.06%	0.47%	-0.01%
13	Machinery, Nec	2.00%	0.67%	0.88%	0.07%	0.38%	0.00%
14	Electrical and Optical Equipment	1.34%	0.78%	0.05%	-0.16%	0.68%	0.00%
15	Transport Equipment	2.19%	0.94%	0.63%	0.15%	0.42%	0.05%
16	Manufacturing, Nec; Recycling	1.52%	0.72%	0.44%	0.20%	0.27%	-0.11%
17	Electricity, Gas and Water Supply	1.21%	0.35%	0.86%	-0.16%	0.16%	-0.01%
18	Construction	1.06%	0.47%	0.41%	0.03%	0.19%	-0.04%
19	Sale, Maintenance and Repair of Motor Vehicles and Motorcycles; Retail Sale of Fuel	0.35%	0.27%	-0.01%	-0.03%	0.12%	0.00%
20	Wholesale Trade and Commission Trade, Except of Motor Vehicles and Motorcycles	0.11%	0.21%	-0.11%	-0.05%	0.08%	-0.03%
21	Retail Trade, Except of Motor Vehicles and Motorcycles; Repair of Household Goods	0.10%	0.18%	-0.07%	-0.05%	0.06%	-0.02%
22	Hotels and Restaurants	0.25%	0.66%	-0.02%	-0.04%	0.04%	-0.40%
23	Inland Transport	0.66%	0.34%	0.29%	-0.09%	0.11%	0.00%
24	Water Transport	0.58%	0.36%	0.20%	-0.07%	0.09%	-0.01%
25	Air Transport	0.71%	0.47%	0.24%	-0.15%	0.18%	-0.03%
26	Other Supporting and Auxiliary Transport Activities; Activities of Travel Agencies	0.22%	0.25%	0.00%	-0.08%	0.09%	-0.05%
27	Post and Telecommunications	0.06%	0.22%	-0.23%	-0.08%	0.17%	-0.01%
28	Financial Intermediation	-0.08%	0.11%	-0.15%	-0.07%	0.05%	-0.02%
29	Real Estate Activities	0.15%	0.10%	0.02%	-0.01%	0.04%	-0.01%
30	Renting of M&Eq and Other Business Activities	-0.06%	0.23%	-0.33%	-0.10%	0.15%	-0.02%
31	Public Admin and Defense; Compulsory Social Security	0.16%	0.20%	-0.04%	-0.04%	0.07%	-0.03%
32	Education	0.10%	0.14%	-0.04%	-0.02%	0.05%	-0.03%
33	Health and Social Work	0.43%	0.33%	0.03%	-0.05%	0.14%	-0.02%
34	Other Community, Social and Personal Services	0.26%	0.28%	-0.05%	-0.04%	0.12%	-0.05%
35	Private Households with Employed Persons	-0.23%	0.27%	-0.53%	-0.16%	0.21%	-0.02%

Source: wiiw calculations

Table 2 presents the third channel of trade policy measures that are estimated as the effects of the respective trade policy measures accumulated on the inputs of production along the GVC by sector. For instance, TBTs improve the cost efficiency of the inputs for the production of 'coke and

petroleum' and 'electrical and optical equipment' with negative accumulated AVE for TBT. However, SPS largely increases the costs of inputs for the former sector. Another sector that is largely affected by higher costs of inputs induced by global SPS is 'basic metals' that is also affected by TBT in the same direction but with much lower magnitude.

An interesting pattern emerges for the services sectors (sectors 17 through 35), where the majority of BRI_3s and τ_{3ih} for NTMs show negative signs. In fact, while tariffs levied on manufacturing products increase the costs of inputs for service providers, regulated NTMs reduce these costs. Market efficiency regulations enhancing the information symmetries, which are directed within TBTs, are good examples that can act in opposite direction of tariffs. Another interesting result in Table 2 is that all sectors are in average facing costs on their inputs induced by TBT STCs represented by positive AVEs. In contrast, majority of sectors benefits from SPS STCs imposed along previous stages of production of intermediate inputs.

5 Impact of NTMs on industrial productivity performance

In this section, the impact of BRIs (first and second channel) and BRI_3s (third channel) on productivity growth is studied as the last step of our investigation. The bilateral AVEs of NTMs imply different cost structures for the direct but also indirect users of intermediate inputs as outlined in the previous section.[7] Higher costs of intermediate inputs do not necessarily harm production. For instance, as argued earlier, a higher quality induced by qualitative regulations embodied within NTMs along the GVC, could result in inputs of production with higher prices. However, such a higher quality can reflect either higher quality of final product or production processes that are more efficient. Both will result in higher gross output, while the latter is caused by higher value-added in the presence of price-cost margin, the former is caused by the higher price for higher quality of final goods.

5.1 Methodological outline and data

As discussed above, BRI_3 indicates the extent to which intermediate inputs are affected by trade policy measures. Starting from a simple Cobb-Douglas function $Y_{iht} = \Psi_{iht} K_{iht}^{\alpha} L_{iht}^{\alpha}, \Psi > 0, 0 < \alpha < 1$ (where, Y, Ψ, K, and L are output, technology (TFP), capital, and labour, respectively), and taking first differences of the logarithmic labour intensive form, we can obtain labour productivity growth as:

$$\Delta y_{iht} = \Delta \psi_{iht} + \alpha \Delta k_{iht} \tag{12}$$

where y_{iht} and k_{iht} are respectively logarithmic forms of output to labour (productivity) and capital to labour ratios, and $\Delta \psi_{iht}$ is the technological progress of industry h in country i at time t, which we

[7] NTMs also affect trade flows as such which are not considered here.

hypothesize to be a function of trade policy (TP) channels and the share of high-skill labour in the given industry $\Delta\psi_{iht} = \gamma_0 TP_{ijht} + \gamma_1 HS_{iht}$.

Since the aforementioned AVE for an NTM on a given industry is a constant effect over the period, we will analyse its impact on the period-averaged annual productivity growth. Plugging the hypothesized technology growth function into equation (12), and using the initial productivity levels to account for convergence, we use the following growth model in our econometric analysis:

$$\overline{\Delta y_{ih}} = \beta_0 + \beta_1 y_{ih,t0} + \beta_2 \overline{\Delta k_{ih}} + \beta_3 \overline{HS_{ih}} + \beta_4 \overline{BRI_{1ih}} + \beta_5 \overline{BRI_{2ih}} + \beta_6 \overline{BRI_{3ih}} + \gamma_{ih} + \mu_{ih} \qquad (13)$$

$$\text{where } \overline{BRI_{1ih}} = \overline{\sum_{J=1}^{J} \frac{v_{ijh}^{m}}{\sum_{J=1}^{J} v_{ijh}^{m}} BRI_{ijh}} \text{ and } \overline{BRI_{2ih}} = \overline{\sum_{J=1}^{J} \frac{v_{ijh}^{x}}{\sum_{J=1}^{J} v_{ijh}^{x}} BRI_{jih}}$$

where $\overline{\Delta y_{ih}}$ is the average annual labour productivity growth of industry *h* in country *i* from 2002 to 2009, $y_{ih,t0}$ is the initial level of productivity in logarithmic form, $\overline{\Delta k_{ih}}$ is the average annual growth of capital to labour ratio. $\overline{BRI_{1ih}}$ and $\overline{BRI_{2ih}}$ refer to the period averaged of first and second channels of trade policy measures discussed before, respectively, which include the summation of all AVEs of NTMs and tariffs. These channels are included in the regression as trade-weighted averages over all bilateral partners for each importing country. v_{ijh}^{m} (v_{ijh}^{x}) is the imports (exports) of industry h from (to) partner j to (from) country i, and J is the total number of partners to i. Thus, $\overline{BRI_{3ih}}$ refers to the third channel of TP measures discussed before, which is the accumulated AVE of four types of NTMs and tariffs on the inputs of industry *h* in country *i* during the period. γ_{ij} denotes a set of industry and/or country-pair specific effects, and μ_{ih} is the error term. We have two main specifications estimating (13). The first specification includes BRIs as the summation of AVEs for NTMs and tariffs as in equation (10). The second specification will estimate the productivity growth over all types of NTMs and tariffs instead of their summations as BRIs for each channel. Since the analysis results in cross section data, we use normal OLS for the estimation of equation (13) with robust standard errors to correct for possible heteroscedasticity.

Data on gross output (GO), value added (VA), employment (l), and sectorial deflator for the fourth stage of analysis are obtained from the WIOD SEA data. Finally, data for Preferential Trade Agreements (PTAs) are taken from WTO. For labour productivity, we use two measurements to study the issue. The first is real gross output divided by employment, and the second is real value added divided by employment. Sectorial value added deflators and exchange rates are used to calculate the real values from the national currency units. This constrains the period of analysis to 2009.

Table 3 – Three BRI Channels' Impact on Productivity Growth

Sectors:	**Non-services**						**Services**					
Dep. Var.:	$\overline{\Delta y_{ih}^{VA}}$			$\overline{\Delta y_{ih}^{GO}}$			$\overline{\Delta y_{ih}^{VA}}$			$\overline{\Delta y_{ih}^{GO}}$		
$y_{ih,2002}$	-0.014**	0.00041	-0.0094	-0.017	-0.0022	-0.031**	-0.00083	0.0028*	-0.012*	0.0030	0.0025	-0.011
	(0.0053)	(0.0023)	(0.0069)	(0.013)	(0.0038)	(0.016)	(0.0030)	(0.0016)	(0.0071)	(0.0029)	(0.0016)	(0.0075)
$\overline{HS_{ih}}$	0.20***	0.030	0.21***	0.19*	0.061	0.21**	-0.022*	-0.033*	0.0023	-0.023**	-0.017	-0.00095
	(0.063)	(0.036)	(0.072)	(0.099)	(0.052)	(0.088)	(0.011)	(0.020)	(0.023)	(0.0099)	(0.021)	(0.023)
$\overline{\Delta k_{ih}}$	0.085**	0.14***	0.092***	0.046	0.088**	0.048	0.21***	0.22***	0.19***	0.11**	0.12**	0.098**
	(0.034)	(0.029)	(0.031)	(0.040)	(0.037)	(0.045)	(0.059)	(0.061)	(0.057)	(0.051)	(0.048)	(0.045)
$\overline{BRI_{1ih}}$	-0.000052	-0.00024	-0.00011	-0.00029	-0.00033	-0.00029						
	(0.00014)	(0.00018)	(0.00015)	(0.00022)	(0.00023)	(0.00024)						
$\overline{BRI_{2ih}}$	-0.000054	0.00031	-0.00014	-0.00033	0.00020	-0.00030						
	(0.00022)	(0.00031)	(0.00024)	(0.00029)	(0.00034)	(0.00031)						
$\overline{IBRI_{3h}}$	0.0018	0.0040**	0.0029	0.0038	0.0038	0.0039	-0.0054**	-0.0014	-0.0053*	0.00052	0.00026	0.00026
	(0.0016)	(0.0016)	(0.0018)	(0.0029)	(0.0027)	(0.0030)	(0.0026)	(0.0026)	(0.0028)	(0.0029)	(0.0027)	(0.0032)
Constant	-0.0053	0.039***	0.024	0.019	0.044***	0.0056	0.042***	0.049***	0.031***	0.056***	0.054***	0.060***
	(0.018)	(0.0085)	(0.022)	(0.026)	(0.011)	(0.036)	(0.0084)	(0.0067)	(0.012)	(0.0079)	(0.0071)	(0.011)
N	627	627	627	627	627	627	709	709	709	709	709	709
R-sq	0.368	0.127	0.400	0.279	0.060	0.318	0.382	0.225	0.451	0.315	0.159	0.423
adj. R-sq	0.319	0.096	0.336	0.224	0.027	0.246	0.342	0.200	0.399	0.270	0.132	0.369
AIC	-1821.6	-1619.1	-1824.5	-1530.0	-1363.2	-1534.6	-2254.3	-2093.8	-2302.2	-2262.4	-2116.7	-2348.2
BIC	-1790.6	-1588.0	-1726.8	-1498.9	-1332.1	-1436.9	-2231.5	-2071.0	-2197.3	-2239.6	-2093.9	-2243.2
γ_i	Yes	No	Yes	Yes	No	Yes	Yes	No	Yes	Yes	No	Yes
γ_h	No	Yes	Yes	No	Yes	Yes	No	Yes	Yes	No	Yes	Yes

Robust standard errors in parentheses
* p<0.1, ** p<0.05, *** p<0.01
Source: wiiw calculations

Table 4 – Direct and Indirect Policy Measures Impact on Productivity Growth

Sectors:	Non-services						Services					
Dep. Var.:	$\overline{\Delta y_{ih}^{VA}}$			$\overline{\Delta y_{ih}^{GO}}$			$\overline{\Delta y_{ih}^{VA}}$			$\overline{\Delta y_{ih}^{GO}}$		
$y_{ih,2002}$	-0.016***	-0.0020	-0.011	-0.019	-0.0039	-0.032**	-0.00048	0.0020	-0.011	0.0028	0.0018	-0.012
	(0.0060)	(0.0023)	(0.0071)	(0.014)	(0.0036)	(0.016)	(0.0030)	(0.0018)	(0.0071)	(0.0030)	(0.0017)	(0.0075)
$\overline{HS_{ih}}$	0.20***	0.045	0.21***	0.18*	0.063	0.19**	-0.019*	-0.032	-0.00012	-0.021**	-0.021	-0.0035
	(0.067)	(0.035)	(0.077)	(0.10)	(0.048)	(0.089)	(0.011)	(0.020)	(0.023)	(0.0097)	(0.021)	(0.023)
$\overline{\Delta k_{ih}}$	0.089***	0.14***	0.099***	0.053	0.093***	0.058	0.21***	0.22***	0.20***	0.11**	0.12**	0.100**
	(0.034)	(0.028)	(0.031)	(0.039)	(0.036)	(0.044)	(0.060)	(0.063)	(0.058)	(0.052)	(0.050)	(0.046)
$\overline{SPS_{1ih}}$	-0.00029	-0.000025	-0.00026	-0.00063**	-0.00018	-0.00053*						
	(0.00021)	(0.00025)	(0.00022)	(0.00030)	(0.00032)	(0.00032)						
$\overline{TBT_{1ih}}$	0.000071	-0.00035	0.000045	-0.000034	-0.00043	-0.000024						
	(0.00023)	(0.00033)	(0.00022)	(0.00031)	(0.00035)	(0.00029)						
$\overline{TBTSTC_{1ih}}$	0.00085	0.0011*	0.00086	0.0012	0.0015	0.0013						
	(0.00053)	(0.00066)	(0.00055)	(0.0010)	(0.0011)	(0.00097)						
$\overline{SPSSTC_{1ih}}$	-0.00014	-0.00031	-0.00036	0.00029	0.000022	0.00038						
	(0.00030)	(0.00048)	(0.00035)	(0.00048)	(0.00051)	(0.00055)						
$\overline{T_{1ih}}$	0.00027	-0.0018**	0.00011	-0.00067	-0.0023**	-0.00083						
	(0.00066)	(0.00085)	(0.00068)	(0.00089)	(0.00094)	(0.00093)						
$\overline{SPS_{2ih}}$	-0.00049	0.00026	-0.00035	-0.0015**	-0.000091	-0.00091						
	(0.00047)	(0.00054)	(0.00045)	(0.00059)	(0.00054)	(0.00061)						
$\overline{TBT_{2ih}}$	0.00010	0.00076*	0.00020	-0.00031	0.00051	-0.000086						
	(0.00032)	(0.00043)	(0.00034)	(0.00044)	(0.00041)	(0.00041)						
$\overline{TBTSTC_{2ih}}$	-0.0000035	0.00066	-0.000072	0.00015	0.00076	0.00011						
	(0.00022)	(0.00045)	(0.00025)	(0.00021)	(0.00048)	(0.00025)						
$\overline{SPSSTC_{2ih}}$	0.0012*	0.0010	0.00068	0.0017**	0.00065	0.00100						
	(0.00064)	(0.00088)	(0.00075)	(0.00077)	(0.00097)	(0.00072)						
$\overline{T_{2ih}}$	-0.0010	-0.0017	-0.0023	-0.0013	-0.0015	-0.0026						
	(0.0014)	(0.0015)	(0.0018)	(0.0016)	(0.0016)	(0.0020)						
$\overline{SPS_{3ih}}$	0.0039**	0.0063***	0.0059***	0.0072**	0.0064**	0.0076**	-0.010**	0.0015	-0.0099**	-0.0047	0.0052	-0.0056

Sectors:	Non-services						Services					
Dep. Var.:	$\overline{\Delta y_{ith}^{VA}}$			$\overline{\Delta y_{ith}^{GO}}$			$\overline{\Delta y_{ith}^{VA}}$			$\overline{\Delta y_{ith}^{GO}}$		
	(0.0019)	(0.0017)	(0.0020)	(0.0033)	(0.0031)	(0.0036)	(0.0042)	(0.0044)	(0.0042)	(0.0056)	(0.0048)	(0.0063)
$\overline{TBT_{3ih}}$	0.0010	0.0082***	0.0016	-0.0000092	0.0077***	0.00070	-0.016**	-0.0059	-0.0086	-0.019***	-0.017***	-0.012*
	(0.0023)	(0.0023)	(0.0025)	(0.0036)	(0.0028)	(0.0034)	(0.0065)	(0.0081)	(0.0065)	(0.0065)	(0.0067)	(0.0066)
$\overline{TBTSTC_{3ih}}$	-0.0085*	-0.0094*	-0.0096**	-0.013	-0.014	-0.015	0.010	0.015	-0.0037	0.032**	0.022	0.017
	(0.0049)	(0.0052)	(0.0047)	(0.0099)	(0.011)	(0.0095)	(0.015)	(0.016)	(0.014)	(0.014)	(0.014)	(0.013)
$\overline{SPSSTC_{3ih}}$	0.015**	0.018**	0.012	0.025*	0.029***	0.019	-0.000074	0.0073	-0.028	0.031	0.019	-0.0032
	(0.0072)	(0.0071)	(0.0076)	(0.013)	(0.010)	(0.012)	(0.026)	(0.032)	(0.027)	(0.031)	(0.029)	(0.028)
$\overline{T_{3ih}}$	-0.00017	-0.00081	-0.00098	0.0054	0.0037	0.0055	0.0019	-0.012	0.0058	0.0060	-0.0061	0.013**
	(0.0022)	(0.0023)	(0.0022)	(0.0045)	(0.0025)	(0.0047)	(0.0060)	(0.0098)	(0.0053)	(0.0056)	(0.0071)	(0.0058)
Constant	-0.0060	0.045***	0.033	0.021	0.054***	0.017	0.040***	0.049***	0.031**	0.053***	0.053***	0.056***
	(0.019)	(0.0092)	(0.025)	(0.028)	(0.011)	(0.038)	(0.0086)	(0.0071)	(0.012)	(0.0083)	(0.0074)	(0.012)
N	627	627	627	627	627	627	709	709	709	709	709	709
R-sq	0.379	0.170	0.416	0.303	0.096	0.340	0.385	0.229	0.454	0.323	0.168	0.429
adj. R-sq	0.316	0.124	0.340	0.233	0.046	0.254	0.341	0.199	0.399	0.275	0.136	0.371
AIC	-1808.5	-1627.1	-1817.6	-1527.0	-1363.9	-1531.2	-2249.7	-2089.1	-2297.6	-2263.3	-2116.8	-2347.2
BIC	-1724.1	-1542.7	-1666.6	-1442.7	-1279.5	-1380.2	-2208.7	-2048.1	-2174.4	-2222.2	-2075.7	-2224.0
γ_i	Yes	No	Yes	Yes	No	Yes	Yes	No	Yes	Yes	No	Yes
γ_h	No	Yes	Yes	No	Yes	Yes	No	Yes	Yes	No	Yes	Yes

Robust standard errors in parentheses
* p<0.1, ** p<0.05, *** p<0.01
Source: wiiw calculations

5.2 Results

Let us summarize the results of this investigation. The estimation of equation (13) is separated into two categories, services and non-services sectors. This separation is mainly done because no tariff and non-tariff data are available for services which are therefore only affected indirectly. Due to production linkages, BRI_3 affects the intermediate inputs of production of services sectors as well as non-services sectors. Stepwise inclusion of sector- and country-fixed effects is considered in the estimations.

Table 3 presents the estimation results of the first specification concerning the impact of three channels of trade policy measures on the average annual labour productivity growth. Control variables show the expected effects on productivity growth in some of the regressions with different fixed effects. Including sector fixed effects γ_h captures the variations across sectors within a country leads to insignificant coefficients for initial labour productivity in non-services. Country fixed effects γ_i explaining large variations in the dependent variables make the initial productivity of value-added in non-services statistically significant and negative, pointing at convergence. Inclusion of both sector and country fixed effects make the convergence statistically significant for gross output productivity in non-services and for value-added productivity in services sectors. Non-services sectors with larger average share of high-skill labour (HS) enjoy larger productivity growth. Statistically positive significant coefficients of the physical capital to labour ratio growth indicate that labour productivity is enhanced by capital. With the large coefficients of growth of high-skill labour share, we observe that the contribution of human capital in labour-productivity growth is larger than the contribution of physical capital growth in manufacturing sectors.

With respect to the variables of interest, the results indicate that there is no statistically significant impact of the first and the second channels (i.e. BRI_{1ih} and BRI_{2ih}) on productivity growth of domestic industries. It indicates that neither BRI faced by the exporting sector nor by the foreign competitors of the given sector influences the growth of labour productivity in that sector. However, the third channel (i.e. BRI_{3ih}) which includes all trade policy measures on the inputs of production accumulated along the upstream stages of the GVC, has statistically significant impact on the labour value-added productivity growth though not in all specifications. Further, these differ with respect to directions for services and non-services sectors.

BRI_3 is statistically significant and positive for commodities (non-services) only when country-fixed effects are not controlled for with respect to value-added productivity growth. Thus, countries that have higher costs of intermediate inputs for their manufacturing sectors enjoy larger value-added productivity growth. While gross output productivity is not affected by the third channel, the results indicate that global trade policy measures imposed along the backward linkages of production

enhances production procedures of countries in manufacturing, resulting in higher value-added productivity growth rather than gross output productivity growth.

However, this third channel of trade policy is negatively related to the value-added productivity growth of services when country-specific effects are controlled using fixed effects. Thus, services sectors with larger costs of intermediate inputs induced by global trade policy measures along the previous stages of production have lower value-added productivity growth.

As discussed earlier, different types of trade policy measures have diverse impact on trade flows for various reasons and consequently affect the productivity differently. In Table 4, we present the second specification estimation results of labour productivity growth over various types of policy measures. Many of these policies do not have any statistically significant impact on the labour productivity via the first and second channel, which is similar to the results obtained in the first specification.

Among these measures, controlling for country fixed effects, SPS in the first and the second channels are linked with lower gross output productivity growth. These two results can be interpreted as follows. From the first channel one can argue that sectors within a country that are protected with SPS measures that are more trade restrictive have lower average annual gross output productivity growth. Productivity in value-added is also negatively affected by the domestic SPS measures but not statistically significantly. For the second channel, it can be interpreted that an industry that faces larger average costs of export due to the imposed SPS measures abroad has lower growth of productivity in gross output.

TBT STC in the first channel imposed by a country that prohibits imports with a high tariff equivalence can be linked with high annual growth of productivity, which is statistically significant for value-added regression controlling for only sector fixed effects. It means countries with restrictive TBT STCs enjoy higher value-added productivity growth in their sectors.

When controlling only for the sector fixed effects, tariffs in the first channel become statistically significant and negative. This firstly indicates that the differences in tariffs are largely across the countries imposing them. It secondly implies that countries that are protected by tariffs more than others have lower annual growth of labour productivity, which might be due to lack of competition in their domestic industries.

TBT in the second channel has positive coefficients in the regressions on value-added productivity but is statistically significant when excluding country fixed effects. This indicates that countries that are facing TBTs that are more restrictive have larger productivity growth in value added. This might relate to the nature of these technical regulations that are usually enforced to increase the quality of products and improve the production procedures.

SPS STCs in the second channel are linked with the larger average annual productivity growth. Controlling for only country-fixed effects, the results suggest that sectors that are facing very

restrictive SPS STC measures have had larger productivity growth. Since these policy measures are special cases of SPS measures that are more restrictive and discriminative, it could indicate that only more productive sectors could pass those barriers.

The third channel of policy measures has larger number of statistically significant coefficients. SPS measures in this channel have statistically significantly positive coefficients in all regressions of non-services sectors. It suggests that the accumulated costs on the inputs of production in previous stages of production by SPS are positively linked to large productivity growth of manufacturing. However, such costs are associated to lower average annual productivity growth in value-added of services sectors.

Controlling for only sector-fixed effects gives positive and statistically significant coefficients of TBTs in the third channel for manufacturing. This suggests that countries that are sourcing intermediate inputs with higher costs associated to TBTs enjoy higher productivity growth in their manufacturing sectors. However, higher TBT costs on inputs of services production are associated with lower gross output productivity growth.

Induced costs of intermediate inputs by TBT STCs have negative impact on the average annual value-added growth in manufacturing sectors. This can indicate the trade restrictiveness of these measures that are unnecessary by nature, which accumulate inefficient costs along the GVC. However, SPS STCs in the third channel are positively linked to the average annual growth of productivity in manufacturing when both sector- and country-specific effects are not controlled at the same time.

Accumulated costs induced by tariffs along the previous stages of production are affecting only gross output productivity growth in services while controlling for sector-country fixed effects. While no tariff is levied against services, these traditional policy tools increase the costs and gross outputs of services.

5.3 Bilateral impacts

As discussed earlier in the introduction, impact of trade policy measures not only varies by types of instruments but also by the countries imposing or facing them. For instance, assume that two countries have similar sets of high regulatory standards, while a third country produces within a lower qualitative standards framework. Thus, a new regulatory measure imposed by one of the two similar countries might have positive influence on the other while having a negative impact on the trade patterns with the third country. Thus, performance of sectors might be affected differently taking the heterogeneous partners in to consideration. Here, we use a similar framework to equation (13) differentiating the first and second trade policy measures by partner countries. Thus, we estimate the following equation:

$$\overline{\Delta y_{\iota h}} = \beta_0 + \beta_1 y_{ih,t0} + \beta_2 \overline{\Delta k_{\iota h}} + \beta_3 \overline{HS_{\iota h}} + \beta_4 \overline{\tau_{1\iota jh}} + \beta_5 \overline{\tau_{2\iota jh}} + \beta_6 \overline{\tau_{3\iota h}} + \gamma_{ij} + \gamma_h + \mu_{ijh} \qquad (14)$$

where $\overline{\tau_{1ijh}}$ includes the trade policy measures in the first channel that are imposed by country *i* against the imports of sector *h* from country *j*, and $\overline{\tau_{2ijh}}$ includes the trade policy measures in the second channel that are imposed by country *j* against the imports of sector *h* from country *i*. γ_{ij} and γ_h are respectively country-pair and sector fixed effects. It is important to mention that the dependent variable is repeated across partners, which can potentially inflate the t-statistics of other variables that are also repeated across partners, making them statistically significant.

Table 5 – Bilateral Direct and Indirect Policy Measures Impact on Productivity Growth

Sectors	Non-Services		Services	
Dep. Var.:	$\overline{\Delta y_{ih}^{VA}}$	$\overline{\Delta y_{ih}^{GO}}$	$\overline{\Delta y_{ih}^{VA}}$	$\overline{\Delta y_{ih}^{GO}}$
$y_{ih,2002}$	-0.0097***	-0.031***	-0.011***	-0.012***
	(0.0010)	(0.0024)	(0.0011)	(0.0011)
$\overline{HS_{ih}}$	0.21***	0.21***	-0.00012	-0.0035
	(0.011)	(0.014)	(0.0035)	(0.0036)
$\overline{\Delta k_{ih}}$	0.097***	0.056***	0.20***	0.100***
	(0.0048)	(0.0069)	(0.0089)	(0.0071)
$\overline{SPS_{1ih}}$	-0.000018	-0.000042		
	(0.000025)	(0.000036)		
$\overline{TBT_{1ih}}$	0.000062***	0.000058**		
	(0.000019)	(0.000025)		
$\overline{TBTSTC_{1ih}}$	0.000052*	0.000078**		
	(0.000028)	(0.000035)		
$\overline{SPSSTC_{1ih}}$	-0.000054*	-0.000026		
	(0.000031)	(0.000041)		
$\overline{T_{1ih}}$	-0.000053	-0.00033***		
	(0.000061)	(0.000090)		
$\overline{SPS_{2ih}}$	0.0000045	0.000017		
	(0.000021)	(0.000024)		
$\overline{TBT_{2ih}}$	-0.000016	-0.000033		
	(0.000023)	(0.000031)		
$\overline{TBTSTC_{2ih}}$	-0.000043	-0.0000088		
	(0.000031)	(0.000034)		
$\overline{SPSSTC_{2ih}}$	0.00014***	0.00016***		
	(0.000029)	(0.000033)		
$\overline{T_{2ih}}$	0.000032	0.000035		
	(0.000046)	(0.000060)		
$\overline{SPS_{3ih}}$	0.0053***	0.0064***	-0.0099***	-0.0056***
	(0.00030)	(0.00054)	(0.00064)	(0.00097)
$\overline{TBT_{3ih}}$	0.0015***	0.00034	-0.0086***	-0.012***
	(0.00030)	(0.00040)	(0.0010)	(0.0010)
$\overline{TBTSTC_{3ih}}$	-0.0057***	-0.0086***	-0.0037*	0.017***
	(0.00054)	(0.0010)	(0.0021)	(0.0020)
$\overline{SPSSTC_{3ih}}$	0.0099***	0.018***	-0.028***	-0.0032
	(0.0011)	(0.0018)	(0.0042)	(0.0044)
$\overline{T_{3ih}}$	-0.0011***	0.0041***	0.0058***	0.013***
	(0.00031)	(0.00063)	(0.00081)	(0.00089)
Constant	0.023***	0.0046	0.031***	0.056***
	(0.0035)	(0.0057)	(0.0019)	(0.0018)
N	25707	25707	29069	29069
R-sq	0.409	0.329	0.454	0.429
adj. R-sq	0.368	0.282	0.421	0.394
AIC	-76941.4	-65052.7	-96363.0	-98395.3
BIC	-76664.1	-64775.4	-96139.5	-98171.8
γ_{ij}	Yes	Yes	Yes	Yes
γ_h	Yes	Yes	Yes	Yes

Robust standard errors in parentheses
* p<0.1, ** p<0.05, *** p<0.01
Source: wiiw calculations

The estimation results are presented in Table 5. Both TBT and TBT STCs in the first channel are associated with higher average annual productivity growth of manufacturing. This indicates that when a country maintains these qualitative NTMs against the imports making the imports more expensive,

the domestic industries benefit by improving their productivities. This reflects that those country-sectors in which majority of exporting partners have faced higher costs of entry by TBTs have larger productivity growth.

As it is observed, protecting the domestic industry by SPS measures do not affect the productivity growth of manufacturing sectors statistically significantly. However, SPS measures for which partner countries have raised STCs affect the domestic average annual growth of value added negatively. This might be due to lack of qualitative improvement by these measures but by reducing the domestic competition. On the other side of trade, SPS STCs maintained by the partner countries, i.e. in the second channel, are associated with higher productivity growth. While these specific measures could be very restrictive and discriminative in nature, only industries with higher productivity could be able to afford the high costs of exports to the country maintaining them.

Tariffs imposed by the domestic countries against exporting partners discourage the productivity growth of gross output statistically significantly. The impact on value-added productivity growth is not statistically significant. This indicates that due to larger tariff protection and reduced market competition, productivity in value-added in domestic manufacturing is not affected, while domestic industries could potentially reduce their prices resulting in lower gross output productivity. However, statistically insignificant coefficients of tariff in the second channel suggest that tariffs imposed by the destination countries do not relate to the productivity of an exporting sector.

As mentioned above, third channel coefficients could become statistically significant in these results due to repeated observations across partners. Coefficients of SPS in the third channel indicate similar results as the results in Table 4 controlling for both sector- and country-fixed effects. A similar result also goes to TBT in the third channel with the coefficients being significant for the value-added productivity growth due to inflation of t-statistics. Yet, the TBT coefficient for manufacturing gross output productivity growth remains insignificant reassuring no statistical relation between induced costs of inputs by TBTs and gross output productivity. A similar conclusion could be drawn from the coefficient of SPS STCs in the gross output productivity growth of services that remains statistically insignificant.

6 Conclusions

In this chapter we track how non-tariff measures (NTMs) trickle through the global value chains (GVCs) and study their impact on industry productivity. The importance of the NTMs as complex trade policy measures is highlighted in various studies of the international trade policy literature. The opaque nature of NTMs distinguishes them from normal tariffs since they have qualitative impact on product flows in addition to price effects. While price effects incurred further up the value chains can be easily tracked along GVC, impact of NTMs on quality of upper stream sectors influence the

production processes along GVC. In this contribution, we present a framework to quantify such impacts.

The contribution of this paper is two-fold. We firstly provide a database for bilateral AVEs of NTMs. This contributes to the existing literature in different ways: a dataset on bilateral AVEs for four types of qualitative NTMs notified to the WTO during a period based on their intensity is a major contribution of this paper. Secondly, we explain labour productivity growth by various types of global trade policy measures incorporated along the GVC.

In a four-stage methodology we estimate the trickling down effect of NTMs and tariffs on labour productivity growth. The first stage estimates the bilateral import demand elasticities using detailed 6-digit bilateral trade flows. The second stage quantifies the bilateral ad-valorem equivalents (AVE) of four types of qualitative NTMs notified to the World Trade Organization (WTO) until 2011 applying a structural gravity model on traded quantities and using the elasticities calculated in previous stage for the period 2002-2011. The third stage uses these estimated AVEs of the four types of NTMs and the average tariffs for the period to calculate the cumulative indirect bilateral-trade restrictiveness indices (BRI_{3ih}) for the inputs of production applying the Leontief technical coefficients consistent with WIOD. Three channels of trade policy measures are discussed as possible channels affecting the performance of industries. The first channel affects the foreign competitors of a given industry through direct trade protectionism measures (BRI_{1ijh}). Second channel is discussed as trade policy measures faced by the exports of a given sector (BRI_{2ijh}). Third channels are considered as BRI_{3ih} that are accumulated along previous stages of production of intermediate inputs. The final stage of the paper analyses the impact of these three channels of trade policy measures on the average annual labour productivity growth.

The results point towards a positive influence of regulations embodied within TBTs and SPS further up the value chains on the performance of non-services industries. Moreover, diverse effects of different types of NTMs are in line with the existing argument within the literature on complexity of these trade policy tools.

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Appendix

Note that all the trade policy measures in the third channel presented below are sorted by the AVE averaged across all sectors.

Figure 2 – Country Average Indirect Tariffs on Inputs - third channel

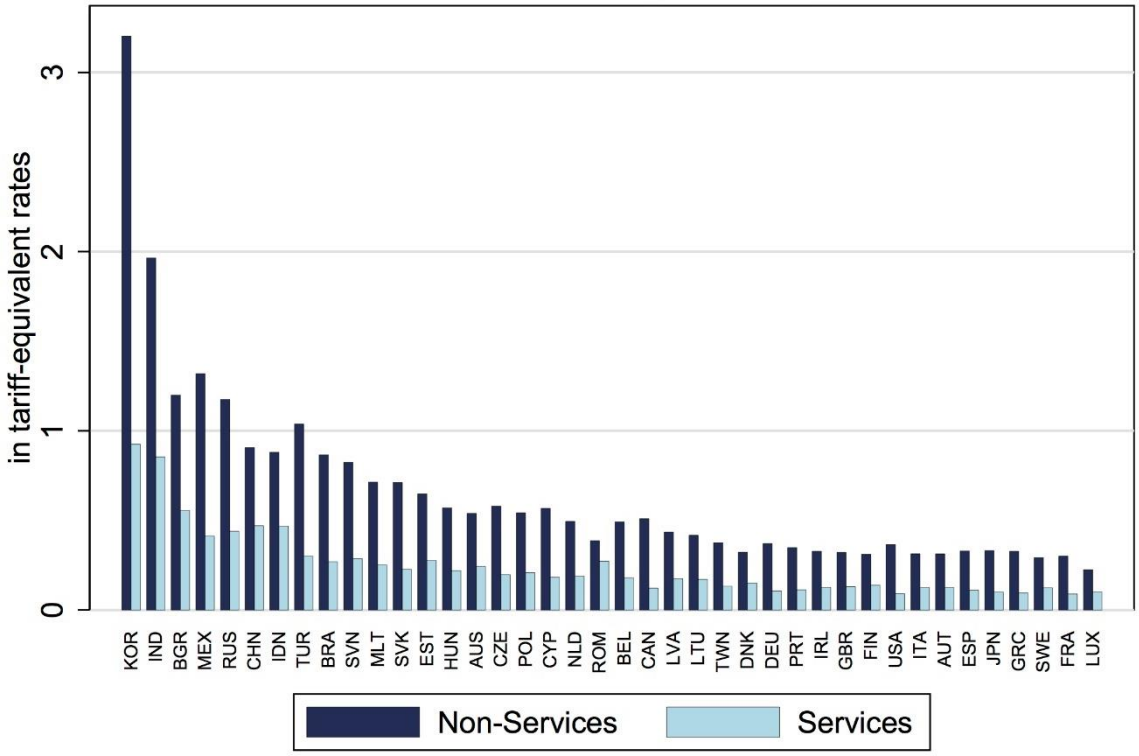

Figure 3 – Country Average indirect AVE for TBT on Inputs - third channel

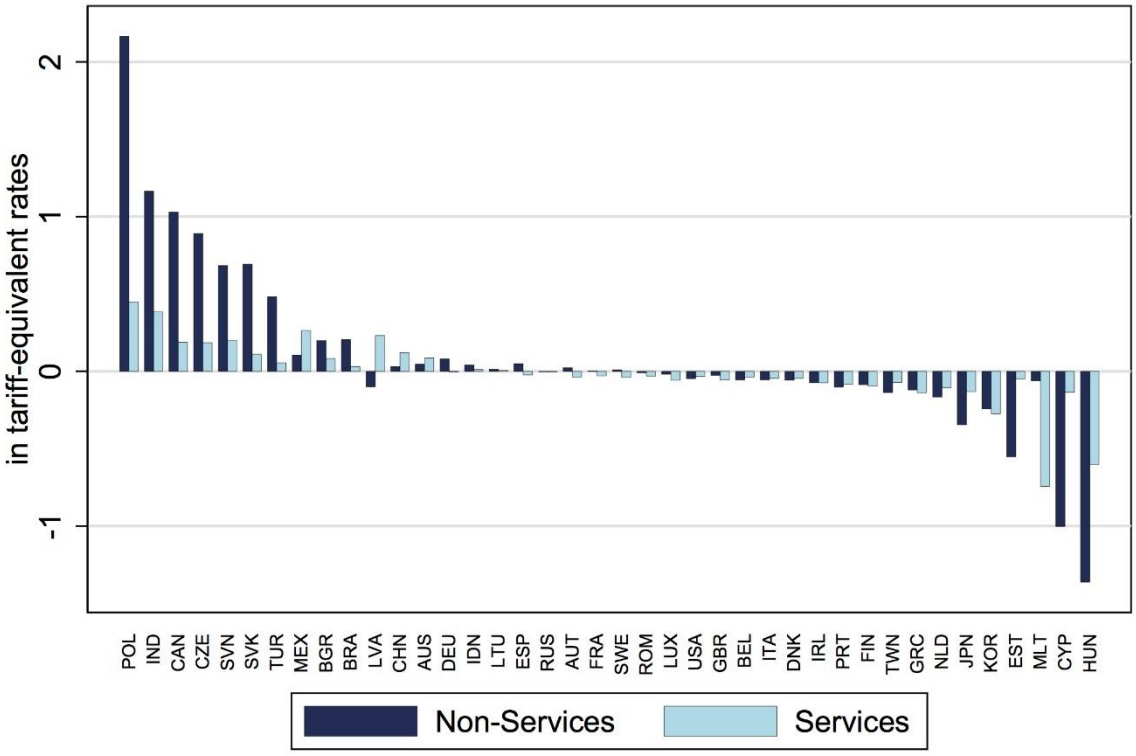

Figure 4 - Country Average indirect AVE for SPS on Inputs - third channel

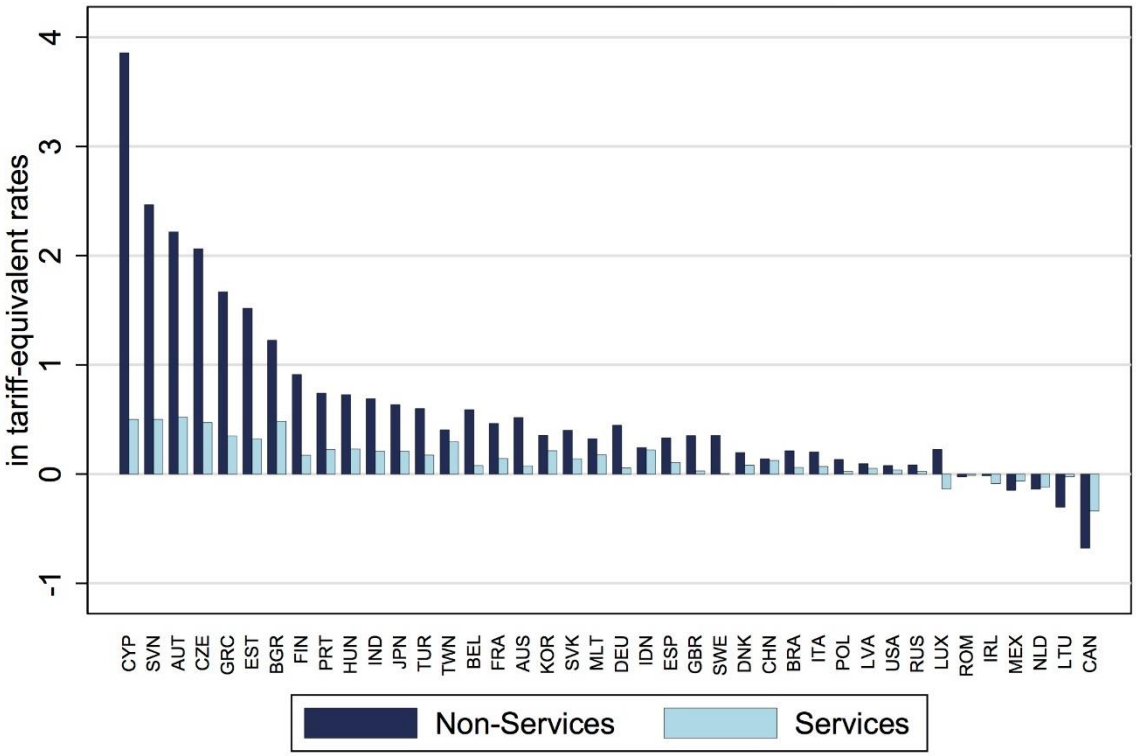

Figure 5 - Country Average indirect AVE for TBT STC on Inputs - third channel

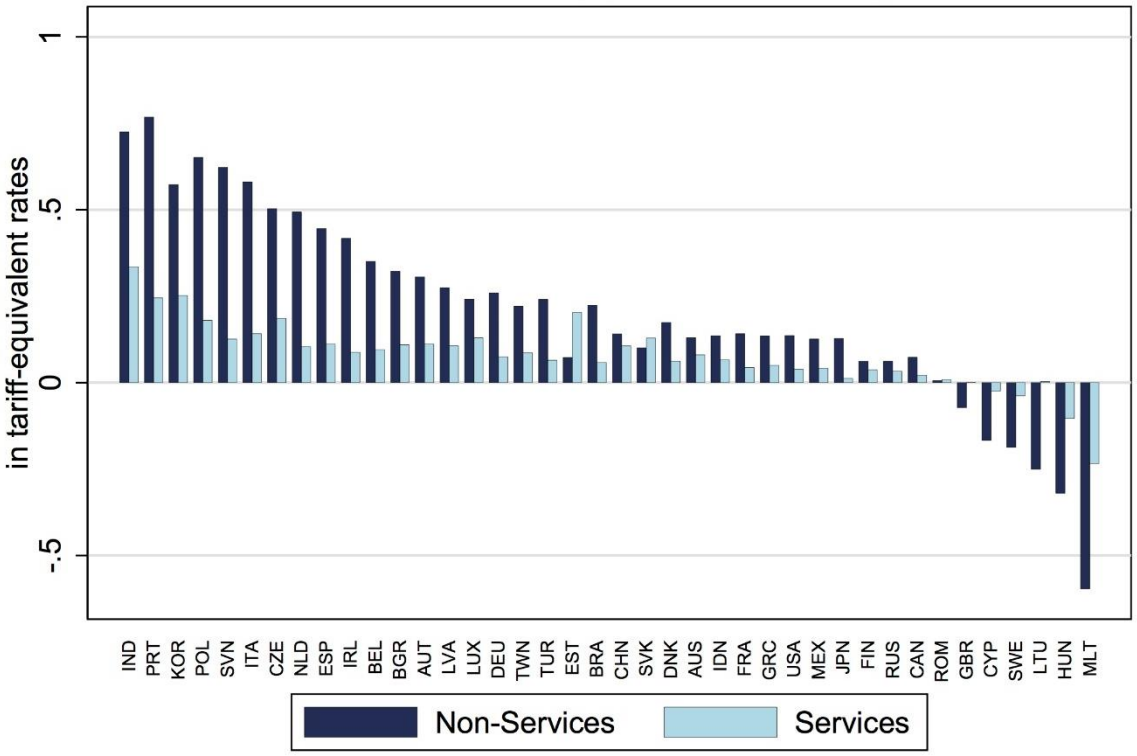

Figure 6 - Country Average indirect AVE for SPS STC on Inputs - third channel