# Tariff reductions, trade patterns and the wage gap

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# Tariff reductions, trade patterns and the wage gap*

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This paper studies the impact of trade liberalization on labor market outcomes. First, we find that bilateral trade liberalization does not affect exports towards third countries. To accommodate this novel result, we deviate from existing literature and rely on a three-country monopolistic competition framework with variable elasticity of substitution and vertical linkages in fixed costs. The resulting model predicts that trade liberalization is ssociated with an increase in the skill-driven wage gap and a reduction in unskilled employment. This prediction is empirically validated using EU-KLEMS data on country-sector wage by skill level on 17 OECD countries from 1996 to 2005.

*JEL codes:* F12 - F16 - J31

*Keywords:* PTAs - Vertical linkages - Trade diversion - Trade creation - Wage gap.

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# 1 Introduction

After two decades of impasse in multilateral negotiations to promote trade, developed countries are turning again towards bilateral and regional deals in the form of Free Trade Agreements (FTAs) and Preferential Trade Agreements (PTAs), whose impact on jobs, wages and inequality is increasingly debated.

Since global trade talks started in Doha in 2001, PTAs have mostly involved developing countries (World Trade Report, 2011, chapter II.B), but the recent EU-South Korea FTA (in 2011) and the start of talks on Japan-EU, Canada-EU, US-EU Transatlantic Trade and Investment Partnership and the Trans-Pacific Partnership show how attractive PTAs are also for more developed economies. Over the period covered by this paper, the average number of PTAs per country surged from 4 in 1996 to 16 in 2008,[1] with a consistent improvement in the market access for exporting countries.[2] The implication of this sustained period of trade liberalization is that all the exporting countries in our sample experienced reductions in the tariffs faced, as shown in Table 1. Moreover, the World Development Report 2009 by the World Bank shows that the fastest growing component of intra-industry trade over the period 1962-2006 is trade in intermediate inputs of production.[3]

We focus on the labor market effects of these changes in the trade policy environment. To this end, we develop a trade model that introduces vertical linkages in a three-country international trade framework with monopolistic competition and two types of workers, skilled and unskilled. We base our model on *ex-ante* empirical evidence (reported in section 2) on the reaction of trade patterns to tariff reduction and PTAs' adoption. The theoretical model is then used to formulate predictions on the labor market effect of trade liberalization, that are subsequently tested using country-sector wage data by skill level on a sample of 17 OECD countries over the period 1996 to 2005.[4]

There is a vast and growing literature on the effects of trade liberalization on trade flows, labor markets and welfare, with a particular acceleration in recent years due to innovations in the modelling approach.[5]

[1] See Figure 1 in Freund and Ornelas (2010).

[2] See section 3.1 for details on the sample of countries used in this paper and on the extent of changes in the market access for the exporting countries in our sample.

[3] See Box 3 (p. 20) in World Bank (2008).

[4] EU KLEMS data on wage by country-sector and skill stops in 2005.

[5] Traditionally, the effects of reductions in trade costs have been analyzed through the lens of a standard Heckscher and

There are currently two competing approaches in studying the labor market implications of tariff liberalization. The first consist in extending the standard *Heckscher-Ohlin mechanism* by introducing heterogeneity in the productivity across producers within sectors, with skill bias technology at the firm level (Burstein and Vogel, 2012). The second approach is based on the introduction of a capital stock accumulation mechanism and capital-skill complementarities into an augmented Ricardian comparative advantage framework (Burstein et al., 2013, Eaton and Kortum, 2002, Krusell et al., 2000). In these models, capital equipment imports alter the ratio of skilled-to-unskilled labor marginal productivity and hence the skill-driven wage gap (also referred to as skill premium). The extent of capital-skill complementarity and the elasticity of substitution between skilled and unskilled labor are calibrated using trade, production and factor share data.[6]

We keep the focus of this literature, but depart from it in the definition of the model to account for our novel empirical results on PTAs and trade flows. We find, in fact, that exports from integrating countries towards third countries are not affected by trade liberalization, which would be inconsistent with the skill-biased-technology extensions of standard Ricardian trade models. However, we do observe that trade liberalization between two countries affects positively bilateral trade and negatively imports from third countries, indicating the presence of *competition effects*. To account for these facts, we opt for a monopolistic competition model characterized by vertical linkages à la Krugman and Venables (1995) and variable elasticity of substitution (Ottaviano et al., 2002, and Melitz and Ottaviano, 2008) which yields market competition effects affecting markups and quantities sold in the integrating countries.[7] In such a framework, a new source

Ohlin mechanism: reductions in trade cost shift factors of production towards the sector in which the country has a comparative advantage. So the skill premium increase in those countries having comparative advantage in skill intensive sectors. However, recent empirical studies have cast doubt on this approach. Harrison and Hanson (1999), on Mexican data, find skill premium increased after the trade reform in 1985, which is puzzling in a Heckscher and Ohlin framework as Mexico has comparative advantage in unskilled intensive goods. Similarly, Goldberg and Pavnick (2007) find that skill premium increased also in unskilled workers abundant countries.

[6]This literature builds on the extensive empirical literature linking international trade and skill intensity of production, see Verhoogen (2008); Bustos (2011); Koren and Csillag (2011).

[7]Specifically, as in Krugman and Venables (1995), we assume that firms use the same set of differentiated goods as those purchased by final consumers and that their benefits from using them take the same form as the consumers' preferences. However, instead of assuming, as in Krugman and Venables (1995), that the elasticity of substitution of varieties is constant and that firms use intermediates inputs in both the variable and the fixed components of the cost functions, following Picard

of gains from trade is identified: savings on the fixed costs for capital investments.[8]

Entrepreneurs can substitute in-house development of equipment with the purchase of intermediates. For example, they can buy computers and software on the market rather than developing them on their own. The savings so achieved can then be used to remunerate the fixed factor (skilled labor). Given that intermediates are not only domestically produced but also imported from other countries, the first implication of our model is that trade liberalization between two countries lowers the cost of intermediates allowing skilled workers to extract higher wages. Moreover, since unskilled workers are employed proportionally to the quantities produced, the second implication is that trade liberalization decreases their employment on the domestic segment while increasing it on the export segment.

The implications of this modelling choice on the skill premium in terms of wage gap and unskilled workers' employment are similar to those resulting from models based on skill-biased technology mechanisms, but our framework implies a different reaction of trade patterns to changes in bilateral trade costs (in line with our empirical findings). Using EU KLEMS data on wage and employment level by education attainment for a set of OECD countries in the period 1996-2005, we find indeed that the wage gap increases with trade liberalization, which is also associated with net unskilled job loss resulting from a decrease in the domestic segment only partially offset by an increase in the export segment.

The results on the impact of tariff liberalization and PTAs in trade flows may appear surprising, considering that the issue has been extensively studied in the literature with a focus on welfare (see Bhagwati, 1993, or Viner, 1950) and trade creation (Soloaga and Winters 2001; Baier and Bergstrand 2007; Silva and Tenreyro 2006; Egger 2004). Yet, the analysis of trade diversion has seldom disentangled importer from exporter specific effects. We do so by using highly disaggregated bilateral trade data from BACI for a set of 187 countries over the period 1996 - 2008. Our results on trade creation between integrating countries and diversion from third ones are in line with the literature (Romalis, 2007, Frankel, Stein and Wei, 1996, Levy, 1997, Bagwell and Staiger, 1999), but we discover a new feature: bilateral trade liberalization is not associ-

and Tabuchi (2013) we assume that the elasticity of substitution is variable and that firms use intermediate inputs only in the fixed component of the cost function as in the Footloose Entrepreneur Vertical Linkage model proposed by Ottaviano (2002), whose properties are discussed in Ottaviano and Robert-Nicoud (2006).

[8]Vertical linkages in fixed costs of capital investments can also be interpreted as a "buy it or make it" choice, as it is sometimes referred to in the literature.

ated with an increase in export flows towards third countries. In other words, the integrating countries trade more with each other (trade creation) and import less from third countries (trade diversion), as expected, but they do not export more to third countries. This result is new in the literature, as it could be captured only by splitting the traditional trade diversion dummy into exporter and importer specific components of diversion.

To build a model consistent with these empirical discoveries, we introduce vertical linkages affecting fixed costs in a variable-elasticity-of-substitution framework.[9] Similarly to Picard and Tabuchi (2013), for the sake of tractability, the same functional form used to capture consumer preferences describes also the fixed-cost savings function.[10] Firms are characterized by a simple production function exhibiting increasing returns to scale through the combination of fixed and variable costs of production. They produce goods that can be used for final consumption or as intermediates by all firms to save on their fixed costs. Workers can be skilled or unskilled, the latter being employed in quantities proportional to total output and the former being hired in fixed quantities to set up a firm. We focus on three countries to be able to identify analytically the effects not only on the integrating countries but also on the excluded ones. Our framework differs from purely theoretical New Economic Geography models with vertical linkages à la Krugman and Venables (1995) because, to ensure empirical tractability, we focus on static properties of the model and assume fixed the number and location of firms (i.e., they are not determined endogenously by the interplay of agglomeration and dispersion forces or by the reduction in fixed costs of entry due to cheaper intermediate goods).[11]

[9]We use a model with variable elasticity of substitution that allows us to take into account the findings by a vast growing empirical literature that shows that markup differ across firms and across markets and respond to international integration processes. Melitz and Ottaviano (2008) and Behrens et al. (2014) represent other contributions in which variable markups are incorporated in trade models. However, both of them do not include intermediates. Moreover, even though the model we present has quasi-linear specifications as in Melitz and Ottaviano (2008), the fact that we consider two types of workers, skilled and unskilled, allows us to depart from the case of factor price equalization that shows up in Melitz and Ottaviano (2008).

[10]Picard and Tabuchi (2013) extend the endogenous mark-ups setup with the linear demand system developed by Ottaviano et al. (2002) to explain the location within a city of firms that produce without variable inputs making use of three different fixed inputs: labor, physical capital equipment and intermediate goods or services.

[11]Starting from the seminal work by Venables (1996), the New Economic Geography literature has shown that intermediates and vertical linkages among firms play a relevant role in determining the space distribution of firms (i.e. Krugman and Venables,1995).

From our theoretical trade model we derive and test the two following properties on the impact of tariff liberalization on the labor market: a decrease in trade barriers is expected (i) to affect negatively employment levels of unskilled workers in country-sectors not enough export oriented and (ii) to increase the wage gap between skilled and unskilled workers.

As for welfare implications, trade liberalization lowers imported goods' prices, increasing profits in the foreign markets and reducing the fixed costs of production due to cheaper intermediates. Therefore skilled workers in the integrating countries are likely to experience improvements in their welfare superior to the losses incurred by skilled workers in the excluded countries (whose only sources of loss are the profits shifted towards the integrating countries due to trade diversion). In addition all consumers in the integrating countries have access to cheaper final goods and a lower price index. However, this result has to be taken *cum grano salis* and is not the main focus of this paper, also because the framework developed here leaves income effects aside for the sake of tractability. Nevertheless, our results contribute to the long-standing debate on the welfare impacts of regionalism as opposed to multilateralism (see Krishna and Panagariya, 2002, or Bhagwati, 1993), confirming that under certain conditions bilateral trade liberalization is both locally and globally welfare improving.

As for the empirical tests of the labor market prediction, the main empirical contribution of this paper is the adoption of a multi-country perspective, going beyond a single-country analysis and working on a panel dataset that includes developed and developing countries over the period 1996-2005. To the best of our knowledge, existing literature focuses solely on single country studies to assess the wage gap effect of trade liberalization (see Feenstra, 2000; Attanasio, Goldberg and Pavnik, 2004; Goldberg and Pavnik, 2005; Gonzaga, Filho and Terra, 2006; Amiti and Davis, 2011; Amiti and Cameron, 2012).[12] Here we explore the cross-country (and time) variation of trade liberalization episodes to derive arguably more general conclusions on the empirical link between trade and labor market outcomes.

The remainder of the paper is organized as follows. Section 2 presents the evidence on the evolution of the impact of tariff reductions and Preferential Trade Agreements on trade patterns. Section 3 introduces the theoretical model and derives the predictions on the labor market impact of trade liberalization, which are then tested in Section 4. Section 5 concludes.

[12]The only partial exception is Behrman, Birdsall and Szekely (2007), who focus on the effect of trade reform on wage differentials for Latin American countries.

## 2 Evidence on trade patterns after trade cost reductions

This section explores the trade creation/diversion effect of Preferential Trade Agreements (PTAs) as an *ex ante* step for our analysis on trade liberalization and wage gap reported in sections 3 and 4. If trade liberalization were found not to have any impact on export flows, there would be no reason to expect an impact on labor market. Further, the empirical evidence on trade diversion provided in this section will guide the theoretical choices made in the next section. Namely, we test whether preferential trade liberalization affects the marginal costs of firms in the exporting country. If preferential trade agreements between the exporter country $i$ and the Rest of the World (RoW) increase the amount of exports to the excluded partner $j$ - *pro-competitive effect* - then it could be inferred that PTAs have altered the marginal costs (competitiveness) of firms in the exporting country.

The empirical exercise reported in this section belongs to a wide literature on trade creation/diversion effect of PTAs, which has a clear conclusion on trade enhancing effect of PTAs, but mixed results on trade diversion.[13] Previous studies test the existence of trade diversion by introducing, in a standard augmented gravity equation, a dummy variable equal to one if the exporter *or* the importer country have a PTA with (at least) a third country. The coefficient associated to this dummy indicates whether the existence of a PTA with a third country diverts trade away from the partner country.[14] Here we are mainly interested in testing what happens to bilateral trade flows $ij$ and $ji$ if the exporting country $i$ has a PTA with a third country $z$. So we depart from the previous literature by splitting the diversion dummy into two components: (i) export diversion or pro-competitive effect (depending on the sign of the estimated coefficient) when the exporting country has a PTA with (at least) one third country, (ii) import diversion when the importing country is in a preferential trade relation with a (at least one) third country. $ExpLib_{it}$ is thus a dummy equal to one if the exporting country $i$ has a PTA with a third country $z$, and indicates a trade diversion effect (if the coefficient is negative) or a pro-competitive effect (if the coefficient is positive) due to $i's$ preferential liberalization with the RoW. Similarly, $ImpLib_{jt}$ is a dummy equal to one if the importing country $j$ has a PTA with a third country $z$, and indicates the existence of a trade diversion effect due to importer's preferential liberalization.

[13] See the World Trade Report (2011) or Freund and Ornelas (2010) for exhaustive survey on trade diversion effect of PTAs.

[14] Trade diversion significatively emerges in some papers (Magee (2008) and Acharya et al. (2011)), but it does not emerge in other papers (Ghosh and Yamarik (2004) and Carrere (2006)).

This simple test is intended to guide our theoretical choices in the next section, notably with respect to the introduction of vertical linkages in the model. As a matter of fact, our results show non-significant coefficients for $ExpLib_{it}$, suggesting that neither export diversion nor with pro-competitive effects are associated with PTAs or tariff reductions.[15] This means that *the availability of cheaper imported intermediate inputs (due to trade liberalization) does not affect firms' marginal costs in the exporting country* while it may still allow firms to save on their fixed costs of production. We thus contribute to the existing literature on trade diversion by providing an explanation for the mixed evidence obtained so far in the literature where importer and exporter effects are not disentangled.

## 2.1 Data

To investigate the trade creation/diversion effect we rely on an augmented gravity equation (Anderson and Van Wincoop 2003; Silva and Tenreyro 2006; Baier and Bergstrand 2007; Head and Mayer 2013). So we build an extensive country pair-product dataset on bilateral export flows, tariffs and PTAs.

Trade data come from BACI (CEPII), which provides information on values and quantities of export flows (in USD and tons, respectively) for a complete set of exporting and importing countries in the period 1989-2008[16] - however our final sample shrinks to the period 1996-2008 because tariff data are available only from 1996. BACI provides trade data at product level (classification HS-6 digit) but we aggregated data at ISIC 2-digit industry level to be consistent with labor market dataset used in section 4. This aggregation also helps the manageability of the dataset that otherwise would count more than 92 million observations.

Tariff data are from TRAINS dataset and refer to effectively applied tariff level for each country pair on a specific HS-4 heading, but then converted at ISIC 2-digit level to the sake of coherence with labor market data.[17] Our main proxy for trade liberalization is thus based on the applied bilateral tariff level from TRAINS. However, to test the diversion effect of preferential trade liberalization we use a Preferential Trade

[15]Notice that a significantly negative coefficient for $ExpLib_{it}$ would have supported the existence of export diversion effects. Instead, a significantly positive coefficient for $ExpLib_{it}$ would have suggested that cheaper intermediates from third countries reduce firms' marginal costs stimulating export flows towards other countries (pro-competitive effect).

[16]The dataset includes observations up to 2012, but we use the trade only up to 2008 to get rid of the highly volatile observations during the recent crisis.

[17]TRAINS provides effectively applied ad-valorem tariff (minimum between preferential and MFN) and ad-valorem equivalent for non-ad valorem measures.

Agreement dummy (PTA) based on a comprehensive list of PTAs available in the WTO website. Such PTA dummy is equal to one if a country pair has a common PTA in force at time $t$.

Other variables come from standard sources: (i) geographic variables (such as distance) come from CEPII dataset;[18] (ii) GDP and population data for both exporting and importing countries are from the World Bank's World Development Indicators. Table A1 shows some in-sample descriptive statistics of the main variables we used in our empirical exercise. In table A1 trade variables statistics are reported for the complete sample of countries and for the sub-sample of OECD countries that we will use in the labor market estimations in section 4.

Our empirical exercise is motivated by the time variation of trade policy environment, i.e. *market access*. Indeed in the last twenty years, the worldwide tariff protection reduced consistently thanks to the proliferation of Preferential Trade Agreements: from 70 PTAs in 1990 to 300 PTAs in 2010 (see Figure B1 of the World Trade Report 2011). More specifically, in Table 1 we use our estimation sample to describe changes in trade policy environment. Table 1 shows the average applied tariffs (both weighted and un-weighted) faced by the group of exporting countries in our sample in the years 1996 and 2008.[19] In this period both OECD and non-OECD countries experienced changes in the applied tariff levels they face in exporting. In particular, non-OECD countries experienced consistent increase in market access through a reduction in the tariffs they face. In the last two columns of Table 1 we show that the total number of countries involved in all PTAs in force roughly doubled over the period 1996-2008.[20]

## 2.2 Estimation strategy

The standard augmented gravity model for our estimates is based on the following regression:

[18] Mayer and Zignago (2011).

[19] The average tariff level faced by the group of exporting countries in our sample has been computed as follows (by using in turn simple and weighted average tariff - weighted by export flows).

$$Tariff_{world,t} = \frac{1}{N}\sum_{n} Tariff_{n,t} \quad (1)$$

where $N$ is the sample of exporting countries $n$. We also replicated this calculation by using a sub-sample of OECD and then non-OECD exporting countries.

[20] In this count, if a country has $n$ PTAs it is counted $n$ times.

$$y_{i,j,s,t} = \phi_i + \phi_j + \phi_s + \phi_t + \beta_1 Log(Tariff + 1)_{ijst} + \beta_2 PTA_{ijt} + \beta_3 ExpLib_{it} + \beta_4 ImpLib_{jt} + \beta_5 X_{ijt} + \varepsilon_{ijst}, \quad (2)$$

where subscripts $i$, $j$, $s$ and $t$ stand respectively for exporter, importer, sector ISIC and year. $y_{i,j,s,t}$ is the quantity exported by country $i$ to $j$ in sector $s$ at time $t$. We focus on export quantity because it will be the crucial trade variable in our theoretical model and to abstract from the impact on prices. However, as a robustness check, we replicate our estimations also on export values (results in appendix Table A2). Explanatory variables capturing bilateral trade liberalization are in turn: (i) the bilateral-sector specific applied tariff level in log ($Tariff_{ijst} + 1$) and (ii) the Preferential Trade Agreement dummy being equal to one if country $i$ and $j$ share a PTA at time $t$ ($PTA_{ijt}$). This last variable is meant here as a simple control, indeed for a proper estimation of a PTA dummy we should accordingly modify our specification (2).[21] The vector of control variables $X_{ijt}$ includes geographic variables traditionally used in estimating gravity model for trade: (i) distance (in ln), (ii) common border, (iii) language and (iv) past colonial linkages.

With respect to the previous literature we change the way to test the trade diversion effect. Instead of using a single dummy (as done in the literature so far), we introduce two dummies, $ExpLib_{it}$ and $ImpLib_{jt}$, being equal to one if, respectively, the exporter and the importer country has a PTA in force with at least one third country ($z$). As robustness, we use instead the total number of PTAs that the exporter and the importer countries have with the rest of the world.

Finally, we include three sets of fixed effects to control for several country, sector and year specific factors affecting trade but not explicitly included in the estimation ($\phi_i, \phi_j$, $\phi_s$ and $\phi_t$ in equation [2]). As robustness check, we improve the previous specification by including country pair-by-sector and year fixed effects. However we cannot include country-year fixed effect because perfectly collinear with our two measures of trade diversion $ExpLib_{it}$ and $ImpLib_{jt}$ (which are country-year specific). For this reason the set of control variables $X_{ijt}$ in equation [2] has been augmented to control for the multilateral resistance term and other

[21] In particular we should properly control for the multilateral resistance term and include country-sector-year fixed effects. This cannot be done in this setting since our two diversion dummies, $ExpLib_{it}$ and $ImpLib_{jt}$, are country-year specific and thus perfectly collinear with country-sector-year fixed effects.

country-year specific factors affecting trade. As a proxy for multilateral resistance term to trade we follow Wei (1996) and use "log GDP-weighted average distances", or *remoteness*. In particular, we follow the definition of remoteness provided by Baldwin and Harrigan (2011) by taking the inverse of the Harris market potential.[22] Then we include also per capita GDP in both exporting and importing country.

The main econometric issue here is the zero trade flows problem (Helpman et al., 2008; Silva and Tenreyro, 2006). In presence of a large number of zeros in bilateral (sector) specific trade flows, the log specification implies the drop of these flows and the resulting OLS estimator is biased (i.e. systematic sample selection of data) and has heteroskedastic error term (Silva and Tenreyro, 2006; Head and Mayer, 2013). A first solution able to keep zero trade flows is to use the log of trade flow plus one. However such solution is too sensitive to the unit of measure and still suffers the heteroskedasticity of the error terms. Although there is not a perfect estimator in presence of zero flows, the recent literature on gravity model estimation mostly recommends a Poisson Pseudo Maximum Likelihood (PPML) estimator (see Head and Mayer, 2013). So we address the zero trade flows problem by using PPML estimator as proposed by Silva and Tenreyro (2006).

The second econometric concern here is endogeneity. However, the omitted variable problem is strongly reduced by the inclusion of fixed effects and control variables able to capture many factors potentially affecting trade flows. Nevertheless, reverse causality is still an issue for tariff and bilateral PTA dummy. Indeed, tariffs and PTA's signature might be affected by bilateral trade flows. However here we are interested mainly in coefficients for $ExpLib_{it}$ and $ImpLib_{jt}$, and tariff and PTA are meant as simple control variables. In our view, $ExpLib_{it}$ and $ImpLib_{jt}$ present reduced reverse causality concerns (though still existing). Unfortunately, finding a valid and relevant instruments for $ExpLib_{it}$ and $ImpLib_{jt}$ has been unfruitful exercise: identifying genuine random variation in PTA's signature with a third country is too complicated and still unsolved issue in the literature. This might call for caution in the causal interpretation of our results.

We estimate equation [2] by using two samples. In the first sample (results in Table 3) we include all the exporting and importing countries having data on trade, tariffs and PTAs (187 exporting and 181 importing countries).[23] By including all the available exporting and importing countries we aim to check the general validity of our results on $ExpLib_{it}$. In the second sample (results in Table 4), we replicate the

[22] $Remoteness_{it} = \left(\sum_j GDP_j/Dist_{ij}\right)^{-1}$

[23] The number of importing countries differs from the number of exporters since we do not have tariff data imposed by Botswana, Faroe Islands, Liechtenstein, Lesotho, Namibia and Swaziland.

same estimations on a sub-sample of OECD countries to check the validity of our results on the sample of countries we will use in the labor market estimations in section 4.

As a final step, to the sake of comparison with the existing literature, we also test the trade creation/diversion effect following the gravity approach used so far in the literature. To this end we estimate the following model:

$$y_{i,j,s,t} = \phi_{it} + \phi_{jt} + \phi_s + \beta_1 Log(Tariff + 1)_{ijst} + \beta_2 PTA_{ijt} + \beta_3 Diversion_{ijt} + \beta_4 X_{ij} + \varepsilon_{ijst} \qquad (3)$$

Variables have the same meaning as before, but now *Diversion* is a dummy variable equal to one if the exporter or the importer country has a PTA with the RoW. Now the diversion term is country pair (time) specific so we can include proper country-by-year fixed effect $\phi_{it}$ and $\phi_{jt}$ to properly control for the multilateral price resistance term. Unfortunately, we could do it only for OLS model because PPML with such huge set of fixed effects suffers a big incidental parameter problem (see Charbonneau, 2012) and is not feasible for computational reasons (convergence in likelihood maximization).

## 2.3 Empirical results and facts on trade creation and diversion

Results on trade creation/diversion for the full sample of countries are reported in Table 3, while in Table 4 we report estimations for the sub-sample of OECD countries used in the labor market estimations in section 4.

The structure of Table 3 is the following. Columns 1-4 show results using fixed effects as in equation [2], while in columns 5-8, as robustness, we improve the specification by including country pair-sector fixed effects.[24] Each specification is estimated on the full sample and on a sub-sample containing only manufacturing sectors (robustness). The structure of Table (4) is slightly different, because, as a further robustness check for this last set of estimations, we drop the top-15 percentile of the distribution of dependent variable since PPML over-weights big observations (Head and Mayer 2013).[25]

[24]When we estimate equation [2] with country pair-sector fixed effects, all those trade flows perfectly predicted by fixed effects are authomatically dropped in estimating non linear model as PPML. That's why the number of observations in columns (1)-(4) differs from those in columns (5)-(8).

[25]The same robustness check has been done for estimations in Table 3 confirming our results. Such robustness checks are

From Table 3 we notice that the coefficient associated with the dummy $ExpLib_{it}$ is never significant - columns 1, 2, 5 and 6 in Table 3. This means that a trade liberalization agreement between countries $i$ and a third country $z$ does not imply any decrease (or increase) in trade flows between $i$ and $j$ (neither *diversion* nor *pro-competitive* effect). It means that a PTA between the exporter country and (at least one) third country does not divert trade away from the partner country $j$ and does not imply any reduction in marginal cost for firms in the exporting country $i$. If cheaper intermediate inputs are available after trade liberalization it does not affect the export performance of firms in country $i$ in exporting to $j$ while it could eventually allow firms to save on their fixed costs of production.

To rationalize this kind of result we develop a new theoretical model where intermediate inputs affect fixed costs rather than marginal costs, making use of a the vertical-linkage framework in which locally produced and imported inputs are used as substitutes for investments. This result is robust also by using the sub-sample of OECD countries - Table 4 - confirming the validity of the results for the sub-sample of countries we will use in our labor market estimations.

We obtain exactly the same evidence if we use the number of PTAs that the exporting country has with the rest of the world (instead of using a simple dummy as before). Columns 3, 7 and 8 in Table 3 confirm what we find so far: null coefficient for $ExpLib_{it}$ even if approximated by the total number of PTAs. Only in column (4) we obtain a positive coefficient suggesting a kind of pro-competitive effect when only manufacturing is considered. However such effect vanishes when we include country pair-sector fixed effects (column 8).

**Fact 1**. *Neither diversion nor pro-competitive effect towards third countries:* a decrease in trade barriers between countries $i$ and $j$ does not increase (or decrease) the exports of $i$ toward a third country $z$.

Turning to the second component of trade diversion effect, $ImpLib_{jt}$, from Table (3) we got negative and significant coefficient suggesting the existence of the traditional diversion effect: if the importing country $j$ has a PTA with a third country $z$, firms in country $j$ reduce their imports from $i$. This result is robust across all specifications in Table 3 (with the exception of column 5) independently of the measure we use ($ImpLib_{jt}$ as a dummy or as the number of PTAs with the rest of the world). This result is also robust if we restrict our sample to OECD countries (Table 4). So the following proposition emerges.

not reported here for simplicity but available under request.

**Fact 2**. *Trade diversion from third countries:* a decrease in trade barriers between the importer country $j$ and a third country $z$ is expected to decrease the imports of country $j$ from country $i$.

Finally, in Table 5 we show results on trade creation/diversion as done so far in the existing literature (i.e. diversion dummy equal to one if exporting or importing country has a PTA with a third country).[26] OLS results in columns 1-3 show the traditional trade creation effects (positive coefficient on PTA dummy). We mainly rely on OLS model to test trade creation effect of PTAs since in this model we can include the proper set of fixed effects (country-year) controlling for the multilateral resistance term. Indeed, we did not include country-year fixed effects in PPML estimations for computational reasons (convergence of max likelihood never achieved). Tariff has the expected sign in both OLS and PPML (columns 1-6).

More interestingly, coefficients on diversion effect are null or (rarely) negative, which is exactly the same (mixed) evidence found so far in the existing literature (see columns 1, 2, 4, 5 and 6). But now, having in mind our previous results in Tables 3 and 4, we might provide an explanation to such mixed evidence. Estimating trade diversion effect with a single dummy, mixes up two different effects: (i) the null trade diversion effect for the exporter country ($ExpLib_{it}$) and (ii) the significant trade diversion effect associated to the importer country ($ImpLib_{jt}$).

The clear cut result emerging from this first empirical exercise concerns the two faces of trade diversion. If the importing country has a PTA with the rest of the world it diverts trade away from the excluded country (*diversion effect*). Differently, when the exporting country has a PTA with the rest of the world, it does not affect its exports to the excluded country (*neither diversion nor pro-competitive effect*). This is itself a new finding for the literature on trade creation/diversion of PTAs, but constitutes here a crucial fact for the theoretical model presented below. Indeed, if the availability of cheaper imported intermediate inputs (due to PTAs with third countries) does not affect the competitiveness of firms in the exporting country, we have to draw a model predicting such peculiar evidence.

[26]With this specification the diversion dummy could not be estimated in the sample of OECD countries because a dummy built in this way would always be equal to one for OECD countries.

### 2.3.1 Robustness check

Strictly speaking, the null effect of $ExpLib_{it}$ might be the result of two opposite effects of trade liberalization: diversion and the pro-competitive effect. When the exporting country $i$ has preferential trade agreement with (at least) a third country $z$, exports to $j$ can reduce because relatively more costly (*diversion*). At the same time, the possibility to import cheaper intermediate inputs from $z$ can boost the competitiveness and thus the exports from $i$ to $j$. Diversion and pro-competitive effect work in opposite direction, and the null coefficient on $ExpLib_{it}$ obtained so far might reflect the perfect balance of these two effects.

Now we want to rule out the diversion effect in order to isolate (and test) the presence of pro-competitive effect from trade liberalization. The diversion effect is based on the fact that having preferential trade relation with a third country $z$ makes less profitable the export to $j$. Thus by restricting the sample of destinations to those countries having similar market access for country $i$, we strongly reduce the space for diversion effect. In this case, if the coefficient on $ExpLib_{it}$ remains null, we may reasonably conclude on the absence of pro-competitive effect of trade liberalization. To select destination countries with similar market access (applied tariff) we use two methods. First, for each exporter-sector-year we calculate the standard deviation and the average tariff across importing countries. Then we select those destination countries having a tariff gap with the average less than one standard deviation unit (then 1.5 as sensitivity test). Second, we select those destination countries with applied tariff between the $25^{th}$ and the $75^{th}$ percentile of the tariff distribution (across destinations, within exporter-sector-year).

So, we re-estimate equation 2 using the sub-sample of destination countries granting similar market access to a given exporter country. Results, reported in Table 6, show again strongly null coefficients for $ExpLib_{it}$. Thus we may reasonably conclude on the absence of any pro-competitiveness effect.

# 3 The model

Following the empirical evidence presented in Section 2, we develop here a model consistent with the observed trade patterns. Consider a world which consists of three countries indexed with $r = i, j, z$ , each populated by $L_r$ identical unskilled workers supplying labor services to a competitive industry producing a homogeneous good and to a monopolistically competitive industry in which each firm produces a variety of a horizontally differentiated good. In addition, in each economy there are $H_r$ identical skilled workers

supplying labor services only to the monopolistically competitive industry. Specifically, each differentiated variety $s$ is associated with a constant marginal cost of production equal to the wage of $c$ unskilled workers. To start production, firms are assumed to face three types of fixed costs, which are given by the requirement to employ, respectively, physical capital equipment, intermediate goods and skilled labor. All the producers in the monopolistic sector employ the same technology and are thus homogeneous in their marginal cost of production. Finally, the three economies are assumed to be symmetric both in consumer preferences and in the production technologies of the two sectors, but they may vary in the size of their populations and in the degree of bilateral integration. We turn now to the description of the demand and supply side of the economy which, given the symmetry of the setting, for ease of exposition will be presented without location identifiers, which are reintroduced when market outcomes are presented.

### 3.1 The demand side

The preferences of each individual $\zeta$ are represented by the following quadratic utility function à la Ottaviano et al. (2002):

$$U(q_0^\zeta; q_s^\zeta, s \in N) = q_0^\zeta + \alpha \int_{s \in N} q_s^\zeta ds - \frac{1}{2}\beta \int_{s \in N} (q_s^\zeta)^2 ds - \frac{1}{2}\gamma \left( \int_{s \in N} q_s^\zeta ds \right)^2 \tag{4}$$

where $q_s^\zeta$ is individual $\zeta'$s consumption of variety $s \in N$ of the differentiated good and $q_0^\zeta$ is its consumption of the homogeneous good which is chosen as the numéraire of the model; $\alpha$, $\beta$ and $\gamma$ are positive preference parameters. Specifically: $\alpha$ represents the intensity of preferences for the differentiated good relative to the homogeneous good; $\beta$ represents the degree of consumers' bias towards product differentiation; and $\gamma$ represents the degree of substitutability between each pair of varieties. The budget constraint of an individual $\zeta$ is

$$\int_{s \in N} p_s q_s^\zeta ds + q_0^\zeta = w^\zeta + \bar{q}_0^\zeta \tag{5}$$

where $p_s$ is the price of variety $s$, $w^\zeta$ is the individual's income and $\bar{q}_0^\zeta$ is his/her initial endowment of the numéraire, which is assumed to be sufficiently large to ensure that consumers have positive demands for the numéraire in equilibrium.

Maximization of (4) subject to (5) yields the following representative consumer $\zeta$ demand function:

$$q_s^{\zeta} = \frac{\alpha}{(\beta + \gamma N)} - \frac{1}{\beta} p_s + \frac{\gamma}{\beta (\beta + \gamma N)} P \tag{6}$$

where $N$ is the measure of consumed varieties (that are also used by firms as intermediates) with average price $\bar{p} = \frac{1}{N} \int_{s \in S} p_s ds$, and the price index $P = N\bar{p}$. As usual in quadratic utilities, the demand for each variety is influenced by three factors, reflected in the three terms of (6). The first term captures consumers' preference for the differentiated good, which applies to all the varieties; the second is the varieties' own price sensitivity; the third can be interpreted as a cross price elasticity of demand with respect to the general price level, $P$, which yields the pro-competitive effects of the quadratic utility. Notice that the resulting linear demand displays variable elasticity of substitution ranging from 0 when $p_s = 0$ to $\infty$ when $q_s = 0$.

### 3.2 The supply side

In the competitive sector, one unit of the homogeneous good is produced with one unit of unskilled labor. The homogeneous good is assumed to be freely traded and is used as the numéraire. This implies that the unit wage of unskilled workers is equal to one in all countries.

In the monopolistic sector, a firm producing variety $s$ employs $c$ units of unskilled labor at the prevailing wage to produce one unit of the good and it incurs a fixed cost of production that consists of three inputs: physical capital equipment, intermediate goods (and services) and skilled labor. Specifically, each firm needs $h$ units of skilled labor (with wage $w_h$) and capital, acquired by the firm at the price of $K$ units of numéraire. Alternatively, as in Picard and Tabuchi (2013), each firm of type $s$ can acquire $q^{\iota}(.)$ units of all intermediate goods at a price $p(.)$ to reduce its need for physical capital. Thus, physical capital and intermediate goods are input substitutes.[27] One interpretation is that a part of the physical capital can be replicated by a set of intermediate inputs at a lower cost. More specifically, the use of a set of all intermediate inputs $q^{\iota}(.)$ (available in the country where the firm is producing) reduces the requirement for physical capital to $K - C(.)$ units of numéraire, where for the sake of tractability $C(.)$ is modelled employing the same functional form

[27] Let us notice that in our paper both the parameters $m$ and $k$, which denote the input-output multipliers in Picard and Tabuchi (2013), are set equal to 1.

as the composite good in the consumers' preferences, that is

$$C(q_x^\iota, x \in N) = \alpha \int_{x \in N} q_x^\iota dx - \frac{1}{2}\beta \int_{x \in N} (q_x^\iota)^2 dx - \frac{1}{2}\gamma \left( \int_{x \in N} q_x^\iota dx \right)^2 \tag{7}$$

and the total cost of intermediates is given by $\int_{x \in S} p_x q_x^\iota dx$. Notice that this cost of intermediates and the expression for $C(.)$ in (7) are common to all firms in the monopolistic sector. Finally, since each firm has to employ $h$ units of skilled workers, fixed costs are given by the following expression

$$f = K - C(.) + \int_{x \in N} p_x q_x^\iota dx \; + hw^H$$

where $w^H$ is the unit wage paid to skilled workers.

As in Picard and Tabuchi (2013), each firm has to set the price $p_s$ for its variety and to determine its demand of intermediate inputs $q^\iota(.)$ produced by other firms. Since the former decision affects operating profits and the latter fixed costs, the two decisions can be disentangled into the maximization of operating profits and the minimization of fixed costs. Given that firm's cost minimization has the same form as the consumer's utility maximization, it entails that the intermediate demand for variety $x$ of each firm has the same form as (6) and is given by

$$q_x^\iota = \frac{\alpha}{(\beta + \gamma N)} - \frac{1}{\beta} p_x + \frac{\gamma}{\beta\,(\beta + \gamma N)} P. \tag{8}$$

Following Picard and Tabuchi (2013), the minimized fixed cost is then given by

$$F = K - S[p(.)] + hw^H, \tag{9}$$

where $S[p(.)]$ are the cost savings due to the use of intermediates and they are given by

$$S[p(.)] = \frac{\alpha^2}{2(\beta+N\gamma)}N - \frac{\alpha}{\beta+N\gamma}\int_{x\in N} p_x dx + \\ -\frac{\gamma}{2\beta(\beta+N\gamma)}\left(\int_{x\in N} p_x dx\right)^2 + \frac{1}{2\beta}\int_{x\in S}(p_x)^2 dx. \tag{10}$$

### 3.3 Market outcomes

Each firm $s$ located in country $r = i, j, z$ produces for market $v = i, j, z$ the quantity that satisfies both the demand of consumers and of firms located in $v$, that is

$$q_{s,rv} = q^{\zeta}_{s,rv}(H_v + L_v) + q^{\iota}_{s,rv}M_v \tag{11}$$

where $q^{\zeta}_{s,rv}$ and $q^{\iota}_{s,rv}$, respectively, denote the demand per consumer and firm located in country $v$ for the production of firm $s$ located in country $r$. The number of skilled and unskilled workers is denoted, respectively, by $H_v$ and $L_v$; the number of firms producing (and thus buying intermediates) in $v$ is given by $M_v$. Moreover, given that $h$ units of skilled workers are employed as a fixed input to produce each variety, assuming full employment, the number of firms in country $v$ can be expressed as

$$M_v = \frac{H_v}{h}.$$

This implies that the price index for the differentiated good in country $v$ is

$$P_v = \int_{x\in N_v} p_{x,rv}dx = \frac{H_i}{h}p_{iv} + \frac{H_j}{h}p_{jv} + \frac{H_z}{h}p_{zv}. \tag{12}$$

Finally, given that all firms are symmetric and they sell in all markets, the number of varieties used as intermediates by firms and consumed by workers is equal in all countries and given by $N_v = M_i + M_j + M_z = N$ with

$$N = \frac{H_i + H_j + H_z}{h}$$

Operating profits of a representative firm that produces in $r$ are obtained by adding operating profits

that derive from sales in all the three countries. Specifically, operating profits obtained by a firm $s$ producing in $r$ from its sales in country $v$ are given by

$$\pi_{s,rv} = (p_{s,rv} - \tau_{rv}c)\, q_{s,rv} \tag{13}$$

where $\tau_{rv} > 1$ denotes iceberg trade costs: each firm producing in $r$ has to ship $\tau_{rv}$ units of its production from $r$ in order to have one unit sold in $v$; $\tau_{rv} = 1$ when $r = v$, that is there are no domestic trade costs. We also assume symmetric trade costs and symmetric reductions, i.e. $\tau_{rv} = \tau_{vr}$. Hence, markets are segmented and each firm can sell its product at different prices in different markets.

Then, making use of (13) and (9), pure profits $\pi_r$ of firm $s$ which produces in country $r$ are

$$\pi_{s,r} = \pi_{s,ri} + \pi_{s,rj} + \pi_{s,rz} - F_{s,r} \tag{14}$$

where minimized fixed costs in $r$, $F_{s,r}$, can differ across the three countries for firms having the same technology because of differences in: (i) the wage of skilled workers $w_r^H$; and (ii) the price of intermediates goods used in $r$ (which is equal to the price of consumption goods available in $r$ because of the optimization of similar functional forms), that is $P_r = \int\limits_{x \in N_r} p_{x,vr}dx$.

In equilibrium, firms earn zero profits and this implies that using (14), the unit wage paid by each firm $s$ at location $r$ to skilled workers is bidded up to

$$w_r^H = \frac{\pi_{ri} + \pi_{rj} + \pi_{rz} - K + S[P_r]}{h}. \tag{15}$$

Since markets are segmented, each firm $s$ producing in $r$ sets its price for market $v$ by

$$max_{p_{s,rv}}\ \pi_{s,rv} = (p_{s,rv} - \tau_{rv}c)\, q_{s,rv}$$

subject to its demand function in $v$

$$q_{s,rv} = \left[\frac{\alpha}{(\beta + \gamma N)} - \frac{1}{\beta}p_{s,rv} + \frac{\gamma}{\beta\,(\beta + \gamma N)}P_v\right](L_v + H_v + M_v)$$

obtained substituting (6) and (8) into (11). Thus, the price set in market $v$ by firm $s$ producing in $r$ is

$$p_{s,rv} = \frac{1}{2}\tau_{rv}c + \frac{\alpha\beta + \gamma P_v}{2\left(\beta + \gamma N\right)}. \tag{16}$$

The profit maximizing price $p_{s,rv}$ and output level $q_{s,rv}$ of a firm with cost $c$ satisfy

$$q_{s,rv} = \frac{\left(L_v + H_v + M_v\right)}{\beta}\left(p_{s,rv} - \tau_{rv}c\right) \tag{17}$$

and maximized profits are

$$\pi_{s,rv} = \frac{\left(L_v + H_v + M_v\right)}{\beta}\left(p_{s,rv} - \tau_{rv}c\right)^2 \tag{18}$$

We can substitute prices from (16) in (12) keeping in mind that $N$ is common to all countries to get

$$P_v = \frac{N\frac{\alpha\beta}{2(\beta+\gamma N)} + \frac{1}{2}\delta_v c}{1 - \frac{\gamma N}{2(\beta+\gamma N)}}, \tag{19}$$

where $\delta_v$ can be interpreted as an inverse measure of openness to trade of country $v$, $\delta_v = M_i\tau_{iv} + M_j\tau_{jv} + M_z\tau_{zv}$. Notice that, if trade is frictionless, then $\tau_{iv} = \tau_{jv} = \tau_{zv} = 1$ and $\delta_v = N$.

Making use of (17), (16) and (19), we get that local sales of a firm producing in $i$ are

$$q_{s,ii} = \frac{L_i + H_i + M_i}{\beta}\left[\alpha\frac{\beta}{2\beta + \gamma N} + \frac{1}{2}\gamma c\frac{H_j\tau_{ji} + H_z\tau_{zi}}{\left(2\beta + \gamma N\right)h} - \mu_i\frac{1}{2}c\right], \tag{20}$$

where $0 < \mu_i = 1 - \frac{\gamma M_i}{(2\beta+\gamma N)} < 1$ as $M_i < N$. The export quantity, respectively, to $j$ and $z$ for a firm producing in $i$ are

$$q_{s,ij} = \frac{L_j + H_j + M_j}{\beta}\left[\alpha\frac{\beta}{2\beta + \gamma N} + \frac{1}{2}\gamma c\frac{H_j + H_z\tau_{zj}}{\left(2\beta + \gamma N\right)h} - \mu_i\frac{\tau_{ij}}{2}c\right] \tag{21}$$

$$q_{s,iz} = \frac{L_z + H_z + M_z}{\beta}\left[\alpha\frac{\beta}{2\beta + \gamma N} + \frac{1}{2}\gamma c\frac{H_z + H_j\tau_{jz}}{\left(2\beta + \gamma N\right)h} - \mu_i\frac{\tau_{iz}}{2}c\right]$$

Thus, it is readily verifiable from (21) that the quantities exported by firms in $i$ towards $j$, $q_{s,ij}$, increase if $\tau_{ij}$ decreases and decrease if $\tau_{jz}$ decreases, as usually found in the literature. However, notice that the same quantities are not affected by a reduction in $\tau_{iz}$, consistently with the empirical patterns described in

the previous section.

Therefore, bilateral trade liberalization (here assumed symmetric, without loss of generality) increases the market access into member countries and stimulates bilateral trade flows. This diverts trade from the excluded country, which experiences a reduction in its exports towards the two integrating countries. Less obvious are the theoretical reasons for the lack of an increase of exports to third countries. Indeed, the bilateral liberalization between country $i$ and $j$ also implies bilateral trade in cheaper intermediate imports. Thus firms producing in countries $i$ and $j$ might, in principle, use cheaper intermediates to substitute physical capital and be more competitive in exporting toward the excluded country $z$. However, in the vertical linkages framework developed here (to meet the empirical results presented in the previous section) intermediates only reduce firms' fixed costs for capital leaving unchanged the operating profit of firms localized in $i$ and $j$. This is a crucial difference with respect to existing models linking trade and labor market outcomes.

In addition to the fixed costs assumption, the lack of increase in exports to third countries stems from the assumption of market segmentation. This former assumption is widely documented in the literature (Engel and Rogers, 2001; Görg, Halpern and Muraközy, 2010) and warrants that changes in market aggregates in one country do not spill over directly to other markets (they may do so only over time, due to an overall reallocation of productive resources in the economies).

In terms of predictions, turning to the labor market outcomes, one proposition can be derived from the model. Noting that unskilled workers are employed proportionally to the quantities produced, it can be noted from (20) and (21) that the number of unskilled workers employed in country $i$ decreases on the domestic segment and increases in the export segment if trade barriers decrease. The overall effect is ambiguous and depends on the parameters of the model.

**Proposition 1**. *Employment loss on the domestic segment:* a decrease in trade barriers for country $i$ is expected to reduce employment of unskilled workers producing in $i$ for the domestic market and increase employment in the export segment.

In other words, once the level of exports is controlled for, a decrease in trade barriers is expected to decrease the employment level of unskilled workers. Here the intuition is straightforward. For a firm producing in country $i$ merely for the domestic market, the reduction in the bilateral trade cost with countries $j$ and $z$ represents just an increase in the competition against imported goods, which reduces the volumes

produced and hence in the employment of unskilled workers. However, the cheaper trade costs will make the export segment more profitable.

Turning to the predictions on the wage gap, making use of (16), (18) and (19), maximized profits of a firm producing in $i$ from local sales and exports in country $j$ and $z$ are respectively given by

$$\pi_{s,ii} = \frac{(L_i + H_i + M_i)}{\beta}\left[\alpha\frac{\beta}{2\beta+\gamma N} + \frac{1}{2}\gamma c\frac{H_j\tau_{ji} + H_z\tau_{zi}}{(2\beta+\gamma N)\,h} - \mu_i\frac{1}{2}c\right]^2; \tag{22}$$

$$\pi_{s,ij} = \frac{(L_j + H_j + M_j)}{\beta}\left[\alpha\frac{\beta}{2\beta+\gamma N} + \frac{1}{2}\gamma c\frac{H_j + H_z\tau_{zj}}{(2\beta+\gamma N)\,h} - \mu_i\frac{1}{2}\tau_{ij}c\right]^2 \tag{23}$$

and

$$\pi_{s,iz} = \frac{(L_z + H_z + M_z)}{\beta}\left[\alpha\frac{\beta}{2\beta+\gamma N} + \frac{1}{2}\gamma c\frac{H_z + H_j\tau_{jz}}{(2\beta+\gamma N)\,h} - \mu_i\frac{1}{2}\tau_{iz}c\right]^2 \tag{24}$$

Notice that domestic profits are expected to be negatively affected by a decrease in trade costs vis-à-vis the other two countries, the more so the higher the number of firms producing abroad. The opposite is true for profits obtained from exports, which increase when the bilateral trade barriers with the trade partner are lowered. However, the effect on profits is negative for firms exporting from third countries towards the integrating countries. The latter suffer a decrease in profits similar to the losses on the domestic market of the firms in the integrating markets, but are not compensated by higher sales elsewhere (differently from the firms in the integrating markets, exporting more to each other). Expressions (22), (23) and (24), together with the expression for $S(P_i)$ can be substituted into (15) to get $w_r^H$.

Using (19) and the following expression

$$\int_{x\in N} p_x^2 dx = \left[\frac{\alpha\beta + \gamma P_i}{2\,(\beta+\gamma N)}\right]^2 N + \frac{1}{4}c^2\frac{H_i + H_j\tau_{ij}^2 + H_z\tau_{iz}^2}{h} + c\frac{\alpha\beta+\gamma P_i}{2\,(\beta+\gamma N)}\delta_i$$

we can rewrite $S(P_i)$ as follows

$$S(P_i) = \frac{1}{2}\alpha^2 N\frac{\beta+\gamma N}{(2\beta+\gamma N)^2} + \frac{1}{4}c\frac{2\alpha\beta + c\gamma\delta_i}{\beta\,(2\beta+\gamma N)} - \frac{1}{8}c\delta_i\,(4\beta+3\gamma N)\,\frac{4\alpha\beta + c\gamma\delta_i}{\beta\,(2\beta+\gamma N)^2} + \frac{1}{8\beta}c^2\frac{H_i + H_j\tau_{ij}^2 + H_z\tau_{iz}^2}{h}$$

which depends on $\tau_{ij}$ and on $\tau_{iz}$, while it is not directly affected by $\tau_{jz}$.[28]

[28]Notice that while $S(P_i)$ is affected by the endowments of skilled workers in the three countries, it is not affected by the

Trade liberalization is expected to increase firms' savings on the fixed costs by allowing them to source cheaper intermediates:

$$\frac{\partial S(P_i)}{\partial \tau_{zi}} = -M_z \frac{1}{2} c \left[ \frac{\alpha}{\beta + \gamma N} - \frac{1}{\beta} p_{s,zi} + \frac{\gamma}{\beta (\beta + N\gamma)} P_i \right] < 0,$$

where $\left[ \frac{\alpha}{\beta+\gamma N} - \frac{1}{\beta} p_{s,zi} + \frac{\gamma}{\beta(\beta+N\gamma)} P_i \right] > 0$ as long as $q_{s,zi} > 0$.

Turning our attention to the wage of skilled workers in $i$, from equation (15) we can see that skilled workers' wages depend on the savings function $S$ and firms' profits in $i$. Hence, the overall effect of changes of $\tau_{zi}$ on the salary is given by

$$\frac{\partial w_i^H}{\partial \tau_{zi}} = \frac{\partial \pi_{s,ii}}{\partial \tau_{zi}} + \frac{\partial \pi_{s,iz}}{\partial \tau_{zi}} + \frac{\partial S(P_i)}{\partial \tau_{zi}}.$$

Since the effect on firms' savings has been shown to be always positive, we only have to check how profits are affected by tariff reduction, i.e. we have to compare $\frac{\partial \pi_{s,ii}}{\partial \tau_{zi}} > 0$ and $\frac{\partial \pi_{s,iz}}{\partial \tau_{zi}} < 0$.

The algebraic sum of the first two addends of $\frac{\partial w_i^H}{\partial \tau_{zi}}$, that is $\frac{\partial \pi_{s,ii}}{\partial \tau_{zi}} + \frac{\partial \pi_{s,iz}}{\partial \tau_{zi}}$, is negative with $\alpha > \tau_{iz}$ and $\alpha > c\tau_{iz}$ if and only if the size of the domestic country $(H_i + L_i)$ is relatively not too large compared with that of the other integrating economy (notice that $M_i$ depends on $H_i$). That is, if

$$\frac{(H_i + L_i + M_i)}{(H_z + L_z + M_z)} < \frac{(2\beta + N\gamma)}{\gamma M_z} \frac{2\beta (\alpha - c\tau_{iz}) + c\gamma (M_z + M_j \tau_{jz} + M_i \tau_{zi} - N\tau_{iz})}{2\beta (\alpha - c) + c\gamma (M_i + M_j \tau_{ji} + M_z \tau_{zi} - N)}$$

Thus, given that $\frac{\partial S(P_i)}{\partial \tau_{zi}} < 0$, a sufficient condition to have $\frac{\partial w_i^H}{\partial \tau_{zi}} < 0$ is that the size of the domestic country $i$ $(H_i + L_i)$ is relatively not too large compared with that of the other integrating economy $z$. Finally, as the numerator (denominator) decreases (increases) with $\tau_{iz}$, the condition above is more likely to hold the smaller the value of $\tau_{iz}$ is. In other words, when two economies are sufficiently integrated, the wage of skilled workers is more likely to increase when there is a reduction in their bilateral trade costs.

Also numerical analysis shows that $w_i^H$ increases if $\tau_{ji}$ decreases for sufficiently integrated small, open country pairs. For instance, Figure 1 shows that $w_i^H$ increases when $\tau_{ji}$ decreases for all relevant values of trade costs (Figure A1). The positive relation between market access (lower $\tau_{ji}$ ) and $w_i^H$ becomes

endowments of unskilled workers.

less obvious when the size of the economies grows (i.e. increases in the endowment of unskilled workers). Figure 1 panel b and c show that such positive relation is true for country pair with sufficiently high initial market access.[29] Specifically, all the cases plotted in Figure 1 show that the wage of skilled workers in the integrating economy increases with the level of market access granted by its partner country, this is always true for country pairs with not too low level of initial integration.[30] We believe that this is the relevant case to be considered here. Indeed, our labor market estimations are based on OECD countries that show high levels of integration in the starting year (as shown in Table 2, for the average tariff level faced by each OECD country in 1996). The increase in the wage of skilled workers in the integrating countries is due to total firms' profits increase as a consequence of lower cost of intermediates $S[N_r, P_r]$ in (10). At first sight, this finding may appear in contradiction with equation (23), in which $\tau_{zi}$ is shown to have no impact on $\pi_{ij}$ , a positive impact on $\pi_{s,iz}$ and a negative impact on the more important domestic market $\pi_{s,ii}$ . It is not so because it should be remembered that the expressions (22), (23) and (24) refer to operating profits, whereas skilled worker wages are paid from total profits, which benefit from the reduction in fixed costs engendered by cheaper intermediates even if such reduction in fixed costs is not passed through to selling prices. Considering that the unskilled workers are remunerated at the wage they could obtain by producing and selling the numéraire, the following proposition holds:

**Proposition 2.** *Trade-liberalization-driven wage gap*: a decrease in the trade barriers faced by country $i$ is expected to increase the wage gap between skilled and unskilled workers in $i$ for sufficiently high levels of trade openness.

Bilateral liberalization between country $i$ and $j$ makes imported intermediate inputs cheaper and thus reduce the fixed costs of the firm. Cheaper intermediate inputs translate into a reduction in the total fixed cost of the firm and thus into increased total profits. Since skilled workers are assumed to be the factor remunerated from total profits (zero profit condition), the wage of skilled workers increases while the wage

[29]All the curves in the figure are obtained for $\tau_{jz} = 4$, $\alpha = 10$, $h = 1$, $\beta = 2$, $c = 0.1$, $\gamma = 2$, $\tau_{zi} = 3$ and $K = 15$. Notice that all the black, red and green lines are, respectively, drawn for $\tau_{ij} < 6.538\,3$, $\tau_{ij} < 7.142\,9$, $\tau_{ij} < 8.125\,0$ so that $q_{ij}(s) > 0$.

[30]The wage of skilled workers in Figure 1 tends to rise in $i$ for a given level of economic integration $\tau_{ij}$, when they become relatively less abundant in unskilled workers (this can be seen for a given value of $\tau_{ij}$ comparing the wage curves of the same colour in the three different panels of figure 1).

of unskilled remains unchanged. That's how bilateral trade liberalization affects the skill premium in this model.

### 3.4 Local and global welfare considerations

Finally, before turning to the empirical validation of the theory, it is worth noting that the system of preferences expressed in (4) can also be used to draw the indirect utility functions capturing the welfare of consumers in the three countries considered:

$$\begin{aligned} W &= \frac{\alpha^2 N}{2(\beta+\gamma N)} - \frac{\alpha}{\beta+\gamma N}\int_{s\in N} p_s ds + \frac{\int_{s\in N}(p_s)^2 ds}{2\beta} \\ &\quad - \frac{\gamma}{2\beta(\beta+\gamma N)}\left(\int_{s\in N} p_s ds\right)^2 + w + \overline{q}_0, \end{aligned} \tag{25}$$

from which it can be noted that[31]

$$\frac{\delta W^{\zeta}}{\delta p_s^{\zeta}} < 0 \quad ; \quad \frac{\delta W^{\zeta}}{\delta w^{\zeta}} > 0.$$

Combining this result with the impact on prices, from equations (16) and (19), and the impact on profits and skilled workers' wages, from equations (22), (23) and (24), we can affirm that the decreases in tariffs are expected to have a positive impact on the welfare of the consumers of the countries involved. Our results confirm Wonnacott's (1996) intuition that the benefits of trade creation are expected to more than offset the losses of welfare caused by trade diversion when PTAs or bilateral tariff reductions result in lower prices. In our model this outcome is driven by the fact that the price index will reflect the higher importance in the bundle of consumption of cheaper varieties imported from the PTA partners.

Turning to the country excluded from the PTA, it should be noticed that their price indices will not be affected by being excluded from a PTA. However, firms' profits and high skilled workers' salaries will be affected negatively from the fact that their exports will face a tougher competition in the markets involved in the PTA.

However, from (23) it can be noticed that the increase in export profits and high skilled workers' salaries in the integrating countries could be higher than the loss of export income in the excluded country. Therefore

[31]The sign of the first derivative is negative as this is consistent with a positive value of quantities in (6).

our model suggests that even a bilateral PTA could be associated with static global welfare gains. Indeed, consumers in the integrating regions could experience improvements in their welfare that exceed the welfare losses incurred by the countries excluded, whose only sources of loss are the profits shifted towards the integrating countries due to trade diversion.

# 4 Testing labor market predictions

This section is devoted to the empirical test of Propositions 1 and 2 outlined in the previous section using a wage-premium estimation strategy based on Revenga (1997).

## 4.1 Data

The labor market data used in this empirical test come from the EU KLEMs dataset[32] reporting information on wage and employment level by skill group (primary, secondary and tertiary education).[33] In particular, we have information on the number of hours worked and labor compensation by country, sector and skill group for a sample of OECD countries in the period 1970-2005. Trade data, tariffs, PTAs and other control variables have the same source as reported in section 2.1.

Since EU KLEMS data are country-sector-year specific, trade related variables have to adjusted accordingly to get rid of the importer country dimension. We thus computed the average tariff faced by each exporting country in a given sector (year) across all its trade partners. Trade data are used here to compute the export orientation of each country-sector (share of country-sector exports over total country's exports). Finally, we use the total number of PTAs by each exporting country as a control variable.

Descriptive statistics in Table 2 show the same kind of evidence as in Table 1 but for each OECD country included in our labor estimations sample. All the OECD countries experienced a reduction in average applied tariff over the period (with the exception of some Eastern European countries). Notice that EU countries here may face different tariff levels because they differ in terms of destination markets (country-sector).

[32]EU KLEMS Growth and Productivity Accounts: March 2008 Release. See Timmer, O'Mahony and van Ark (2007) for further details.

[33]In what follows we classify tertiary and secondary educated workers as "Skilled" and primary educated workers as "Unskilled" workers

## 4.2 Empirical Specification

Propositions 1 and 2 suggest that a decrease in trade costs due to a reduction in protection by trading partners (improved market access) implies a reduction in unskilled workers' employment and an increase in the wage gap between skilled and unskilled workers. In particular, our theoretical model predicts the reduction of unskilled employment in the domestic segment of production. However we have no information on the allocation of labor into domestic vs foreign market segment of the firm; so we can test this proposition only indirectly as described below. In order to test these two propositions, we estimate the following simple reduced-form wage and employment equations using aggregated exporters-sector-year data:

$$ln(\frac{SkilledWage}{UnskilledWage})_{i,s,t} = \phi_{i,t} + \phi_{s,t} + \beta_1 Log(Tariff + 1)_{i,s,t} + \beta_2 X_{i,s,t} + \varepsilon_{i,s,t} \tag{26}$$

and

$$ln(UnskilledEmployment)_{i,s,t} = \phi_{i,t} + \phi_{s,t} + \beta_1 Log(Tariff + 1)_{i,s,t} + \beta_2 X_{i,s,t} + \varepsilon_{i,s,t} \tag{27}$$

where $i$, $s$ and $t$ denote respectively exporter country, sector ISIC and year. Our main explanatory variable is the log of average tariff level (plus one) faced by each exporter across all his destination markets (sector specific average across all partner countries). We include exporter-year ($\phi_{i,t}$) and sector-year ($\phi_{s,t}$) fixed effects to control for the exporter-year and sector-year specific characteristics. Country-year fixed effects capture differences in labor market characteristics (legislation) among countries (i.e. rigidities in labor market) and any macroeconomic dynamics in each country. Sector-year fixed effects capture sector specific shock common to all countries (i.e. technological and productivity shocks).[34]

In a first set of estimates we do not include country-year fixed effects, but use a set of control variables ($X_{i,s,t}$) including the GDP and the population size by exporter country, the number of PTAs signed by each country.[35] Then, the export orientation of each sector in a given country has been included as control variable in all the estimations (as the share of sector specific exports over total country's exports). Export

[34]Country-Sector fixed effects could not be included since there is not enough time variation in the tariff variable for a given country-sector. Indeed, much of the variation in tariff levels shown in Table 2 is due to sector composition of exports by OECD countries.

[35]Indeed, we want to make sure that our tariff variable keeps the effect of a reduction in the variable cost of exporting and not simply a better market access, as suggested by Goldberg and Pavnik (2005).

orientation, being sector-country-time specific is not collinear with the set of fixed effects included, and it is meant to capture the combined effect of all trade related channels - other than trade liberalization (tariffs) - on relative wages.[36]

The export orientation also allows us to indirectly test whether the effect of trade liberalization on unskilled employment is peculiar to the domestic segment of the firm (as predicted by *Proposition 1*). So by interacting the tariff variable with the export orientation of the sector, we are able to check whether the negative effect of trade liberalization on unskilled employment is weaken for those firms in export intense sector. The idea behind this test is that firms will produce more (and thus employ more unskilled workers) in the export segment offsetting the reduced employment in the domestic segment. We can expect that the net effect of bilateral trade liberalization on unskilled employment depends on the relative importance of these two segments: the higher the export share of production, the lower the unskilled employment loss due to trade liberalization.

While the number of fixed effects and control variables included in the estimation crucially reduce the omitted variable problem, some concerns on the simultaneity of tariff level need to be addressed. Indeed, as highlighted by Goldberg and Pavnick (2005) simultaneity bias could go either way. If trade liberalization pushes more productive (or able) workers from liberalized to protected sectors, the coefficient on tariff level would be upward biased. But it may also happen that firms respond to trade liberalization by firing less productive (or able) workers, which would imply that the remaining workers represent a sample of more productive and better paid workers, which bias the tariff coefficient. In other words, tariff variable could capture the pure tariff liberalization effect and the indirect effect through the sample of workers (sample selection). To solve this problem we use an instrumental variable approach. We follow the idea by Goldberg and Pavnik (2005), who argue that tariff reductions in each sector are proportional to the initial level (pre-tariff liberalization), and use the tariff level in the starting year as first instrumental variable.

However, the former instrument does not vary over time, hence we also use the three-year lagged tariff level to instrument the contemporaneous tariff level. But, in case of time persistence of tariff level, the three year lags cannot be considered exogenous (validity problem), so we use a further set of instruments. We

[36]Export orientation controls for the trade specialization (i.e. sector comparative advantage) of the exporter country, which (combined with labor market frictions) can affect the wage and the employment level of the country, as recently shown by Carrere et al.(2014).

assume that country-sector specific tariff level could be approximated by: (i) the average sector-specific tariff level (average across countries $i$ by sector $s$) and (ii) the country-specific tariff level (average across sectors within country $i$).

The three sets of instruments described above are very correlated with the country-sector specific tariff level suggesting their relevance. First stage results of our 2SLS are reported at the bottom of Tables 7, 8, 9.

### 4.3 Main results on labor market outcomes

In order to test *Proposition 1* - employment loss on the domestic segment - Tables 7 has to be read in combination with Table 3. In particular, Table 7 shows the results for both OLS and 2SLS estimations on the level of unskilled employment in different sectors.[37]

Assuming that the employment of unskilled workers is proportional to production, we can then indirectly capture the effect of a reduction in trade barriers on the domestic vs exporting segment employment. Indeed, whereas our results in Table 3 state that a reduction in bilateral trade costs (tariff) boosts trade and thus increases employment in the export segment, the coefficients in Table 7 on the tariff reduction effect on total unskilled employment is positive and statistically significant; meaning that a reduction in trade barriers reduces the number of unskilled workers employed in the sector.[38] The combination of these two results represents a first piece of evidence in favour of *Proposition 1.* Moreover, the negative coefficient of the interacted term between tariff and export orientation suggests that a tariff reduction reduces on average unskilled employment with a lesser extent in high export oriented sectors. To the sake of interpretation of the interacted variable, notice that the average value for the export intensity variable is 3%; thus a 10% reduction in tariff level correspond to a 2.3% reduction in the employment level of unskilled workers in non-

[37]First stage regression results reported in the bottom part of Table 7 show the relevance of our instrumental variables. Initial tariff level and the three year lag of tariff are good proxies for the current tariff level. Similarly the average tariff level by country and product are good predictors for the current tariff level; moreover in this last case, since we have an overidentified model, we can also conclude on the exogeneity of the instruments. According with the Sargan test the validity assumption is satisfied. The same arguments apply for 2SLS estimations on wage gap and skilled wage in the bottom part of Tables 8 and 9.

[38]As a further robustness check we estimate equation (27) on the unskilled workers intensity of the sector expressed as share of total number of hours worked by unskilled over total workers. Results, available under request, show that tariff reductions are associated with decreases in unskilled intensity, i.e. trade liberalization reduces the employment of unskilled workers as a share of total workers. The previous effect is attenuated by the export intensity of the sector.

exporting sectors (column 2), which shrinks to a 2% reduction in those sectors having mean export intensity. The negative effect of tariff reductions on unskilled employment is offset in those sectors with more than 30% export intensity (very rare in our dataset).

As for the impact on skilled workers' wages analyzed in *Proposition 2 (trade-liberalization-driven wage gap)*, our model yields much starker results. The increase in total profits due to cheaper imports in a framework characterized by vertical linkages implies that skilled workers can bid up their salary and increase the ratio between their earnings and the unskilled workers' earnings. Tables 8 and 9 confirm this prediction, which is robust to a wide set of controls and different estimation strategies. In fact, we test the trade-liberalization-driven wage gap in two slightly different ways. First, since the unskilled workers' wage is equal to the value of the numéraire in the model, we look at the ratio between skilled wages and unskilled wage (Table 8). Then, for additional robustness, instead of the ratio we consider the level of skilled workers' earnings controlling for unskilled workers' earnings among the covariates (Table 9).

The two sets of regressions yield qualitatively identical results and confirm the prediction of *Proposition* 2: as the trade barriers decrease, the skill premium rises. This result holds statistically significant for a large number of different specifications. In Table 8 the coefficient for tariffs is always negative and significant, according to our preferred specification in column (2), a 10% reduction in the tariff faced by the country implies a 2.5% increase in the wage gap. 2SLS results confirm what described so far, coefficients on tariffs are negative and significant. First stage statistics show the relevancy of the instrument (always significantly correlated with tariffs), and the Sargan test for the over-identified model in column (8) shows the validity of the instruments. In Table 9 the coefficient for tariff is again always negative (though not significant in columns 4-7 for the increase in the standard errors). This again suggests that trade liberalization increases the wage of skilled workers (conditioned in the wage of unskilled, here included as control in all estimations).

# 5 Conclusions

In this paper, we have analyzed the impact of bilateral tariff reductions and PTAs on the involved parties and on third countries. We did so by using a three-country monopolistic competition model with vertical linkages on fixed costs and a skill heterogeneity in the labor market. The theoretical model departs from existing frameworks on trade and labor market outcomes by taking into account three relevant empirical

facts, highlighted in our empirical analysis on trade liberalization: (i) bilateral trade agreements are found to increase trade flows between the integrating countries; (ii) the integrating countries do not export more towards third countries, but divert trade away from third countries by importing less of their products.

The theoretical model built to account for these empirical facts yields two interesting predictions on the labor market implications of trade liberalization. First, among the countries involved in the integration process, unskilled workers' employment levels decrease on the lines of production serving the domestic market and increase in the lines of production serving the export segment. The overall effect is not a priori determined but depends on sector characteristics such as export intensity or the relative importance of entry barriers and product differentiation. Second, reductions in trade barriers increase the skill-driven wage gap in the integrating countries when these are sufficiently open to trade. Empirically, as for the first prediction, we do observe a strong decline in unskilled workers' employment following trade liberalization, with a lesser extent for sectors highly export oriented. As for the second prediction, we find that the difference in remuneration between skilled and unskilled workers in the OECD economies widens when trade barriers fall.

The paper also contributes to the debate on the welfare effect of PTAs. Since prices in the integrating countries fall and real wages increase under fairly general conditions, tariff reductions and PTAs are locally welfare improving for the participants of the agreements and are likely to be globally beneficial. This result is inferred theoretically from the observation that the only loss in the third countries stem from the reduction in their export profits, which are shifted to producers in the integrating countries.

Our results hold in the short run, i.e. holding the number and location of firms and workers fixed. We also disregard in this analysis general equilibrium feedback effects on input prices for the sake of tractability. A promising future avenue of research would be to investigate the dynamic and general equilibrium properties of the model and test whether its results are robust to the introduction of endogenous entry and exit of firms and/or relocation patterns. For example, the additional entry due to the cost savings associated with trade liberalization may result in dynamic gains increasing exports to third countries. Still, the focus on static properties allowed us to obtain clear predictions to test empirically and keep a tight connection between the theory and the empirics. However, discerning between static and dynamics effects in such an extension of the model, while at the same time empirically validating it, would not constitute a trivial pursuit.

# Tables

Table 1: Tariff and PTAs changes. Full sample. Period 1996-2008.

| | Average Tariff (in %) | | Weighted Average Tariff (in %) | | N. Partners with PTA | |
|---|---|---|---|---|---|---|
| | 1996 | 2008 | 1996 | 2008 | 1996 | 2008 |
| World | 7.94 | 5.53 | 6.92 | 4.57 | 2525 | 4968 |
| OECD | 3.66 | 3.12 | 1.74 | 1.62 | 347 | 777 |
| Non OECD | 8.50 | 5.82 | 7.60 | 4.92 | 2178 | 4191 |

*Average Tariff*: average applied tariff faced by each group of countries.
*Weighted Average Tariff*: average applied tariff weighted by export values.
*Partners with PTA*: total number of destination markets with PTA. If a destination country has $n$ PTAs, it is counted $n$ times.
*Source*: Authors' calculation on TRAINS and WTO data.

Table 2: Tariff and PTAs changes. OECD countries. Period 1996-2008.

| | Average Tariff (in %) | | Weighted Average Tariff (in %) | | Partners with PTA | |
|---|---|---|---|---|---|---|
| Country | 1996 | 2008 | 1996 | 2008 | 1996 | 2008 |
| Australia | 6.73 | 4.37 | 4.52 | 3.14 | 14 | 16 |
| Austria | 3.13 | 2.21 | 0.11 | 0.22 | 17 | 58 |
| Czeck Republic | 2.29 | 2.40 | 0.17 | 0.12 | 24 | 58 |
| Denmark | 2.62 | 2.10 | 0.33 | 0.19 | 30 | 58 |
| Finland | 2.01 | 2.22 | 0.29 | 0.46 | 17 | 58 |
| Germany | 2.61 | 2.11 | 0.24 | 0.36 | 30 | 58 |
| Hungary | 1.64 | 2.03 | 0.09 | 0.21 | 23 | 57 |
| Italy | 2.89 | 2.38 | 0.23 | 0.69 | 30 | 57 |
| Japan | 7.39 | 5.76 | 6.05 | 6.39 | 0 | 12 |
| Korea | 11.47 | 8.02 | 13.57 | 8.59 | 40 | 46 |
| Netherland | 2.80 | 2.20 | 0.17 | 0.33 | 30 | 58 |
| Poland | 1.75 | 2.13 | 0.12 | 0.14 | 23 | 58 |
| Slovakia | 1.37 | 2.03 | 0.04 | 0.10 | 21 | 55 |
| Slovenia | 0.91 | 2.94 | 0.04 | 0.25 | 22 | 55 |
| Spain | 2.72 | 2.13 | 0.19 | 0.50 | 23 | 58 |
| United Kingdom | 2.66 | 2.20 | 0.37 | 0.40 | 30 | 58 |
| United States | 6.18 | 4.88 | 1.60 | 4.34 | 3 | 15 |

*Average Tariff*: average applied tariff faced by each country.
*Weighted Average Tariff*: avg applied tariff weighted by export values.
*Partners with PTA*: total number of destination markets with PTA.
*Source*: Authors' calculation on TRAINS and WTO data.

Table 3: Trade liberalization and export quantities. Full sample of countries over the period 1996-2008. PPML estimation.

| Dep Var: | Export Quantity | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| | (1) | (2) | (3) | (4) | (5) | (6) | (7) | (8) |
| Exp Lib (dummy) | 0.034 | 0.110 | | | 0.064 | 0.040 | | |
| | (0.069) | (0.086) | | | (0.042) | (0.030) | | |
| Imp Lib (dummy) | -0.177*** | -0.251*** | | | -0.060 | -0.047** | | |
| | (0.049) | (0.060) | | | (0.039) | (0.023) | | |
| Exp Lib (n. of PTAs) | | | 0.024 | 0.086** | | | 0.028 | 0.013 |
| | | | (0.027) | (0.034) | | | (0.020) | (0.013) |
| Imp Lib (n. of PTAs) | | | -0.067*** | -0.090*** | | | -0.042*** | -0.024*** |
| | | | (0.021) | (0.024) | | | (0.016) | (0.009) |
| Ln(tariff+1) | -0.104*** | -0.028 | -0.103*** | -0.027 | 0.010 | -0.026*** | 0.010 | -0.026*** |
| | (0.021) | (0.020) | (0.021) | (0.020) | (0.011) | (0.006) | (0.011) | (0.006) |
| PTA dummy | -0.009 | 0.017 | -0.005 | 0.015 | 0.012 | -0.011 | 0.023 | -0.003 |
| | (0.040) | (0.042) | (0.043) | (0.045) | (0.021) | (0.011) | (0.023) | (0.013) |
| Distance (ln) | -0.934*** | -0.996*** | -0.934*** | -0.996*** | | | | |
| | (0.040) | (0.045) | (0.040) | (0.045) | | | | |
| Colony | 0.224*** | 0.241*** | 0.225*** | 0.240*** | | | | |
| | (0.079) | (0.077) | (0.079) | (0.077) | | | | |
| Common Language | 0.184*** | 0.245*** | 0.184*** | 0.245*** | | | | |
| | (0.044) | (0.046) | (0.044) | (0.046) | | | | |
| Contiguity | 0.341*** | 0.394*** | 0.340*** | 0.393*** | | | | |
| | (0.068) | (0.073) | (0.068) | (0.073) | | | | |
| Fixed Effects: | | | | | | | | |
| Country | yes | yes | yes | yes | no | no | no | no |
| Sector | yes | yes | yes | yes | no | no | no | no |
| Year | yes | yes | yes | yes | yes | yes | yes | yes |
| Country pair-by-sector | no | no | no | no | yes | yes | yes | yes |
| Sample | Full | Only Manufacturing | Full | Only Manufacturing | Full | Only Manufacturing | Full | Only Manufacturing |
| Observations | 490,258 | 396,799 | 490,258 | 396,799 | 484,171 | 388,778 | 484,171 | 388,778 |

All specifications include also per capita GDP and remoteness for both exporting and importing countries

Standard errors in parentheses are clustered at country pair level. *** $p < 0,01$; ** $p < 0,05$; *$p < 0,1$.

Table 4: Trade liberalization and export quantities. OECD countries over the period 1996-2008. PPML estimations.

| Dep Var: | Export Quantity | | | | | |
|---|---|---|---|---|---|---|
| | (1) | (2) | (3) | (4) | (5) | (6) |
| Exp Lib (dummy) | -0.127 | -0.169 | -0.167** | | | |
| | (0.149) | (0.134) | (0.079) | | | |
| Imp Lib (dummy) | -0.204** | -0.292*** | -0.192*** | | | |
| | (0.085) | (0.109) | (0.071) | | | |
| Exp Lib (n. of PTAs) | | | | -0.105 | -0.109 | -0.031 |
| | | | | (0.069) | (0.072) | (0.047) |
| Imp Lib (n. of PTAs) | | | | -0.037 | -0.066 | -0.062*** |
| | | | | (0.042) | (0.045) | (0.023) |
| Ln(tariff+1) | 0.011 | 0.012 | -0.036* | 0.011 | 0.012 | -0.034* |
| | (0.039) | (0.038) | (0.020) | (0.039) | (0.037) | (0.020) |
| PTA dummy | 0.094 | 0.149** | 0.062* | 0.107 | 0.167** | 0.079** |
| | (0.064) | (0.060) | (0.032) | (0.075) | (0.071) | (0.036) |
| Distance (ln) | -1.301*** | -1.334*** | -1.000*** | -1.302*** | -1.335*** | -1.001*** |
| | (0.070) | (0.069) | (0.042) | (0.070) | (0.069) | (0.042) |
| Colony | 0.032 | 0.079 | 0.322*** | 0.035 | 0.084 | 0.324*** |
| | (0.108) | (0.108) | (0.081) | (0.108) | (0.107) | (0.081) |
| Common Language | 0.259*** | 0.333*** | 0.325*** | 0.258*** | 0.332*** | 0.324*** |
| | (0.062) | (0.064) | (0.034) | (0.062) | (0.064) | (0.034) |
| Contiguity | 0.419*** | 0.366*** | -0.067 | 0.418*** | 0.365*** | -0.066 |
| | (0.104) | (0.110) | (0.069) | (0.104) | (0.110) | (0.069) |
| Fixed Effects: | | | | | | |
| Country | yes | yes | yes | yes | yes | yes |
| Sector | yes | yes | yes | yes | yes | yes |
| Year | yes | yes | yes | yes | yes | yes |
| Sample | Full | Only Manufacturing | Top 15 Pctile removed | Full | Only Manufacturing | Top 15 Pctile removed |
| Observations | 156,168 | 121,640 | 115,406 | 156,168 | 121,640 | 115,406 |

All specifications include also per capita GDP and remoteness for both exporting and importing countries

Standard errors in parentheses are clustered at country pair level. *** $p < 0,01; * * p < 0,05; *p < 0,1$.

Table 5: Trade creation and diversion. Full sample and OECD countries. Period 1996-2008.

| Dep Var: | Export Quantity | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| | (1) | (2) | (3) | (4) | (5) | (6) | (7) | (8) | (9) |
| PTA dummy | 0.053 | 0.079* | 0.217*** | -0.018 | 0.007 | 0.005 | 0.078 | 0.126** | 0.049 |
| | (0.040) | (0.044) | (0.067) | (0.038) | (0.040) | (0.020) | (0.062) | (0.057) | (0.031) |
| Diversion | -0.137 | -0.188 | | -0.194 | -0.347 | -0.194** | | | |
| | (0.288) | (0.320) | | (0.180) | (0.229) | (0.099) | | | |
| Ln(tariff+1) | -0.169*** | -0.110*** | -0.109*** | -0.104*** | -0.028 | -0.059*** | 0.013 | 0.015 | -0.033* |
| | (0.017) | (0.018) | (0.034) | (0.021) | (0.020) | (0.011) | (0.039) | (0.037) | (0.020) |
| Distance (ln) | -1.550*** | -1.625*** | -1.899*** | -0.934*** | -0.996*** | -0.839*** | -1.300*** | -1.333*** | -1.000*** |
| | (0.031) | (0.033) | (0.070) | (0.040) | (0.045) | (0.019) | (0.069) | (0.069) | (0.042) |
| Colony | 0.594*** | 0.656*** | 0.643*** | 0.222*** | 0.239*** | 0.263*** | 0.029 | 0.076 | 0.319*** |
| | (0.124) | (0.144) | (0.157) | (0.079) | (0.077) | (0.071) | (0.108) | (0.108) | (0.081) |
| Common Language | 0.352*** | 0.375*** | 0.600*** | 0.184*** | 0.244*** | 0.196*** | 0.259*** | 0.333*** | 0.324*** |
| | (0.039) | (0.042) | (0.059) | (0.044) | (0.046) | (0.023) | (0.062) | (0.065) | (0.034) |
| Contiguity | 0.418*** | 0.415*** | 0.199 | 0.341*** | 0.393*** | 0.101** | 0.418*** | 0.365*** | -0.067 |
| | (0.083) | (0.092) | (0.126) | (0.068) | (0.073) | (0.043) | (0.104) | (0.110) | (0.069) |
| Fixed Effects: | | | | | | | | | |
| Country | no | no | no | yes | yes | yes | yes | yes | yes |
| Sector | yes | yes | yes | yes | yes | yes | yes | yes | yes |
| Year | no | no | no | yes | yes | yes | yes | yes | yes |
| Country-by-year | yes | yes | yes | no | no | no | no | no | no |
| Method | OLS | OLS | OLS | PPML | PPML | PPML | PPML | PPML | PPML |
| Sample | Full | Only Manufac. | OECD | Full | Only Manufac. | Top 15 Pctile removed | OECD | OECD Manufac. | OECD Top 15 pctile removed |
| Observations | 517,627 | 420,673 | 159,256 | 490,258 | 396,799 | 395,576 | 156,168 | 121,640 | 115,406 |

All specifications include also per capita GDP and remoteness for both exporting and importing countries

Standard errors in parentheses are clustered at country pair level. *** $p < 0,01$; ** $p < 0,05$; *$p < 0,1$.

Table 6: Trade liberalization and export quantities. Full sample and OECD exporting countries. Period 1996-2008.

| Dep Var: | Export Quantity | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| | (1) | (2) | (3) | (4) | (5) | (6) | (7) | (8) | (9) |
| Exp Lib (dummy) | -0.016 | | -0.161 | -0.008 | | -0.184 | 0.198** | | 0.093 |
| | (0.083) | | (0.130) | (0.074) | | (0.124) | (0.093) | | (0.162) |
| Imp Lib (dummy) | -0.252*** | | -0.316*** | -0.176*** | | -0.260*** | -0.148*** | | -0.076 |
| | (0.066) | | (0.122) | (0.058) | | (0.099) | (0.056) | | (0.095) |
| Exp Lib (n. of PTAs) | | 0.012 | | | 0.009 | | | 0.016 | |
| | | (0.038) | | | (0.032) | | | (0.037) | |
| Imp Lib (n. of PTAs) | | -0.096*** | | | -0.071*** | | | -0.088*** | |
| | | (0.027) | | | (0.024) | | | (0.024) | |
| Ln(tariff+1) | -0.146*** | -0.143*** | 0.074 | -0.098*** | -0.097*** | 0.071 | -0.025 | -0.026 | -0.007 |
| | (0.027) | (0.027) | (0.046) | (0.024) | (0.024) | (0.043) | (0.035) | (0.035) | (0.076) |
| PTA dummy | 0.006 | 0.014 | 0.217*** | -0.022 | -0.016 | 0.133* | 0.140*** | 0.176*** | -0.028 |
| | (0.048) | (0.052) | (0.067) | (0.044) | (0.048) | (0.068) | (0.051) | (0.057) | (0.063) |
| Distance (ln) | -0.965*** | -0.965*** | -1.324*** | -0.938*** | -0.938*** | -1.311*** | -0.845*** | -0.845*** | -1.208*** |
| | (0.043) | (0.043) | (0.078) | (0.041) | (0.041) | (0.073) | (0.049) | (0.048) | (0.137) |
| Colony | 0.193** | 0.194** | 0.007 | 0.231*** | 0.232*** | 0.009 | 0.505*** | 0.514*** | 0.624*** |
| | (0.083) | (0.083) | (0.110) | (0.083) | (0.083) | (0.110) | (0.123) | (0.122) | (0.117) |
| Common Language | 0.227*** | 0.227*** | 0.260*** | 0.207*** | 0.207*** | 0.260*** | -0.046 | -0.049 | 0.288*** |
| | (0.047) | (0.047) | (0.065) | (0.045) | (0.045) | (0.063) | (0.057) | (0.057) | (0.085) |
| Contiguity | 0.394*** | 0.394*** | 0.429*** | 0.375*** | 0.375*** | 0.431*** | 0.048 | 0.047 | 0.416* |
| | (0.070) | (0.070) | (0.106) | (0.069) | (0.069) | (0.106) | (0.093) | (0.094) | (0.236) |
| Similarity criterion | ((Tariff-Mean Tariff)/Std Tariff)$\leq$ 1 | | | ((Tariff-Mean Tariff)/Std Tariff)$\leq$ 1.5 | | | Tariff between 25 and 75 percentile | | |
| Fixed Effects: | | | | | | | | | |
| Country | yes | yes | yes | yes | yes | yes | yes | yes | yes |
| Sector | yes | yes | yes | yes | yes | yes | yes | yes | yes |
| Year | yes | yes | yes | yes | yes | yes | yes | yes | yes |
| Country pair-by-sector | no | no | no | no | no | no | no | no | no |
| Sample | Full | Full | OECD | Full | Full | OECD | Full | Full | OECD |
| Observations | 372,498 | 372,498 | 128,213 | 420,389 | 420,389 | 135,267 | 177,216 | 177,216 | 29,573 |

All specifications include also per capita GDP and remoteness for both exporting and importing countries

Standard errors in parentheses are clustered at country pair level. *** $p < 0,01; ** p < 0,05; *p < 0,1$.

Table 7: Trade liberalization and the employment of unskilled workers. OECD countries over the period 1996-2005.

| | Log of (unskilled workers) | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| | (1) | (2) | (3) | (4) | (5) | (6) | (7) | (8) | (9) |
| Ln(tariff+1) | 0.157*** | 0.230*** | 0.308*** | 0.201*** | 0.245*** | 0.367*** | 0.430*** | 0.277*** | 0.595*** |
| | (0.0382) | (0.0401) | (0.0462) | (0.0444) | (0.0474) | (0.0620) | (0.130) | (0.0577) | (0.118) |
| GDP(ln) | | 0.280 | 0.333 | | | | -0.330 | 0.296 | -0.0105 |
| | | (0.252) | (0.260) | | | | (0.403) | (0.209) | (0.231) |
| Population (ln) | | 2.955*** | 2.920*** | | | | 3.505*** | 2.860*** | 3.959*** |
| | | (0.588) | (0.629) | | | | (0.759) | (0.481) | (0.595) |
| N. of PTAs | | 0.0693 | 0.0367 | | | | 0.0567 | 0.0788 | 0.0931 |
| | | (0.0915) | (0.0966) | | | | (0.0729) | (0.0601) | (0.0615) |
| Export Orientation | | 1.475*** | 1.578*** | | 1.459*** | 1.439*** | 1.230*** | 1.109*** | 0.956*** |
| | | (0.363) | (0.546) | | (0.338) | (0.531) | (0.387) | (0.307) | (0.327) |
| Export Orientation*Ln(Tariff+1) | | -0.778*** | -0.800*** | | -0.783*** | -0.734*** | -0.622*** | -0.559*** | -0.479*** |
| | | (0.208) | (0.300) | | (0.188) | (0.282) | (0.216) | (0.171) | (0.181) |
| Fixed Effects: | | | | | | | | | |
| Country | yes | yes | yes | no | no | no | yes | yes | yes |
| Sector | no | no | no | no | no | no | yes | yes | yes |
| Year | no | no | no | no | no | no | yes | yes | yes |
| Sector-Year | yes | yes | yes | yes | yes | yes | no | no | no |
| Country-Year | no | no | no | yes | yes | yes | no | no | no |
| Sample | Full | Full | No Oil and metals | Full | Full | No Oil and metals | Full | Full | Full |
| Model | OLS | OLS | OLS | OLS | OLS | OLS | 2SLS | 2SLS | 2SLS |
| First Stage IV results | | | | | | | | | |
| IV: Lag Tariff | | | | | | | 0.277*** | | |
| IV: Country Avg Tariff | | | | | | | | 0.610*** | |
| IV: Sector Avg Tariff | | | | | | | | 0.469*** | |
| IV: Initial Tariff | | | | | | | | | 0.411*** |
| Joint F-stat | | | | | | | 17.37 | 70.98 | 67.17 |
| Sargan Test | | | | | | | | 0.214 | |
| Observations | 1,439 | 1,379 | 1,150 | 1,439 | 1,379 | 1,150 | 965 | 1,379 | 1,379 |
| R-squared | 0.933 | 0.934 | 0.941 | 0.942 | 0.941 | 0.948 | 0.933 | 0.932 | 0.926 |

Robust standard errors in parentheses. *** $p < 0,01$; ** $p < 0,05$; * $p < 0,1$.

Table 8: Trade liberalization and the wage of skilled/unskilled workers - wage premium. OECD countries over the period 1996-2005.

| | Log of (skilled wage/unskilled wage) | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| | (1) | (2) | (3) | (4) | (5) | (6) | (7) | (8) | (9) |
| Ln(tariff+1) | -0.218*** | -0.247*** | -0.319*** | -0.308*** | -0.330*** | -0.436*** | -0.477** | -0.206** | -0.665*** |
| | (0.0528) | (0.0555) | (0.0676) | (0.0616) | (0.0640) | (0.0853) | (0.204) | (0.0886) | (0.147) |
| GDP(ln) | | 0.245 | 0.284 | | | | 0.970* | 0.270 | 0.666** |
| | | (0.330) | (0.345) | | | | (0.507) | (0.281) | (0.308) |
| Population (ln) | | -1.842** | -1.834** | | | | -2.524** | -1.665** | -3.060*** |
| | | (0.786) | (0.852) | | | | (1.061) | (0.677) | (0.754) |
| N. of PTAs | | -0.145 | -0.123 | | | | -0.143 | -0.161** | -0.181** |
| | | (0.114) | (0.120) | | | | (0.0955) | (0.0809) | (0.0821) |
| Export Orientation | | -0.115 | -0.0804 | | -0.0881 | -0.0599 | -0.152 | -0.144 | -0.141 |
| | | (0.151) | (0.266) | | (0.142) | (0.254) | (0.147) | (0.133) | (0.140) |
| Fixed Effects: | | | | | | | | | |
| Country | yes | yes | yes | no | no | no | yes | yes | yes |
| Sector | no | no | no | no | no | no | yes | yes | yes |
| Year | no | no | no | no | no | no | yes | yes | yes |
| Sector-Year | yes | yes | yes | yes | yes | yes | no | no | no |
| Country-Year | no | no | no | yes | yes | yes | no | no | no |
| Sample | Full | Full | No Oil and metals | Full | Full | No Oil and metals | Full | Full | Full |
| Model | OLS | OLS | OLS | OLS | OLS | OLS | 2SLS | 2SLS | 2SLS |
| First Stage IV results | | | | | | | | | |
| IV: Lag Tariff | | | | | | | 0.278*** | | |
| IV: Country Avg Tariff | | | | | | | | 0.654*** | |
| IV: Sector Avg Tariff | | | | | | | | 0.506*** | |
| IV: Initial Tariff | | | | | | | | | 0.419*** |
| F-stat | | | | | | | 28.25 | 118.21 | 0.129.29 |
| Sargan Test | | | | | | | | 0.678 | |
| Observations | 1,369 | 1,309 | 1,096 | 1,369 | 1,309 | 1,096 | 918 | 1,309 | 1,309 |
| R-squared | 0.944 | 0.941 | 0.942 | 0.952 | 0.949 | 0.951 | 0.939 | 0.939 | 0.936 |

Robust standard errors in parentheses. *** $p < 0,01; * * p < 0,05; * p < 0,1$.

Table 9: Trade liberalization and the wage of skilled workers. OECD countries over the period 1996-2005.

| | Log of (skilled wage) | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| | (1) | (2) | (3) | (4) | (5) | (6) | (7) | (8) | (9) |
| Ln(tariff+1) | -0.0447*** | -0.0335* | -0.0397** | -0.0338 | -0.0328 | -0.0342 | -0.0828 | -0.0561** | -0.151*** |
| | (0.0169) | (0.0178) | (0.0195) | (0.0209) | (0.0218) | (0.0254) | (0.0629) | (0.0260) | (0.0494) |
| GDP(ln) | | -0.276*** | -0.276*** | | | | -0.150 | -0.248*** | -0.163* |
| | | (0.106) | (0.105) | | | | (0.168) | (0.0899) | (0.0974) |
| Population (ln) | | 0.123 | 0.101 | | | | -0.228 | 0.132 | -0.168 |
| | | (0.253) | (0.266) | | | | (0.347) | (0.206) | (0.253) |
| N. of PTAs | | 0.0359 | 0.0409 | | | | 0.0427 | 0.0384* | 0.0328 |
| | | (0.0322) | (0.0303) | | | | (0.0263) | (0.0222) | (0.0231) |
| Export Orientation | | -0.0282 | 0.117 | | -0.0204 | 0.129* | -0.0328 | -0.0352 | -0.0354 |
| | | (0.0467) | (0.0787) | | (0.0452) | (0.0729) | (0.0428) | (0.0388) | (0.0384) |
| Unskilled wage (ln) | 0.0633*** | 0.0613*** | 0.0616*** | 0.0729*** | 0.0729*** | 0.0727*** | 0.0674*** | 0.0590*** | 0.0662*** |
| | (0.0123) | (0.0125) | (0.0107) | (0.0136) | (0.0138) | (0.0119) | (0.0141) | (0.0113) | (0.0128) |
| Fixed Effects: | | | | | | | | | |
| Country | yes | yes | yes | no | no | no | yes | yes | yes |
| Sector | no | no | no | no | no | no | yes | yes | yes |
| Year | no | no | no | no | no | no | yes | yes | yes |
| Sector-Year | yes | yes | yes | yes | yes | yes | no | no | no |
| Country-Year | no | no | no | yes | yes | yes | no | no | no |
| Sample | Full | Full | No Oil and metals | Full | Full | No Oil and metals | Full | Full | Full |
| Model | OLS | OLS | OLS | OLS | OLS | OLS | 2SLS | 2SLS | 2SLS |
| First Stage IV results | | | | | | | | | |
| IV: Lag Tariff | | | | | | | 0.271*** | | |
| IV: Country Avg Tariff | | | | | | | | 0.649*** | |
| IV: Sector Avg Tariff | | | | | | | | 0.498*** | |
| IV: Initial Tariff | | | | | | | | | 0.406*** |
| F-stat | | | | | | | 27.27 | 116.94 | 119.19 |
| Sargan Test | | | | | | | | 0.842 | |
| Observations | 1,369 | 1,309 | 1,096 | 1,369 | 1,309 | 1,096 | 918 | 1,309 | 1,309 |
| R-squared | 0.922 | 0.925 | 0.923 | 0.934 | 0.934 | 0.932 | 0.922 | 0.921 | 0.917 |

Robust standard errors in parentheses. *** $p < 0,01$; ** $p < 0,05$; * $p < 0,1$.

**Appendix**

Table A1: Descriptive statistics

| | Mean | Standard Deviation | Min | Max | N. Observations | Sample |
|---|---|---|---|---|---|---|
| Exported Value | 26219 | 78348 | 0 | 748224 | 517781 | Full |
| Exported Quantity | 16124 | 61821 | 0 | 711913 | 517781 | Full |
| Tariff | 5.35 | 15.9 | 0 | 3700 | 517781 | Full |
| PTA | - | - | 0 | 1 | 517781 | Full |
| Exported Value | 41520 | 96554 | 0 | 748141 | 159256 | OECD |
| Exported Quantity | 21598 | 69932 | 0 | 711913 | 159256 | OECD |
| Tariff | 3.03 | 19.13 | 0 | 3000 | 159256 | OECD |
| PTA | - | - | 0 | 1 | 159256 | OECD |
| Wage high skill | 17.04 | 5.99 | 7.41 | 44.87 | 1249 | OECD |
| Wage low skill | 4.1 | 3.4 | 0.029 | 1881 | 1249 | OECD |
| Skill Premia | 20.48 | 81.1 | 0.44 | 1289 | 1249 | OECD |
| Hours worked high skill | 81.12 | 13.49 | 37.1 | 99.73 | 1249 | OECD |
| Hours worked low skill | 18.87 | 13.49 | 0.262 | 52.89 | 1249 | OECD |

*Notice*: In the bottom panel, observations strongly reduce since labor market variables are not destination country specific.

Table A2: Trade liberalization and export values. PPML estimation.

| Dep Var: | Export Values | | | | | |
|---|---|---|---|---|---|---|
| | (1) | (2) | (3) | (4) | (5) | (6) |
| Exp Lib (dummy) | -0.116* | -0.092 | | | -0.081*** | |
| | (0.062) | (0.063) | | | (0.031) | |
| Imp Lib (dummy) | -0.177*** | -0.200*** | | | -0.079*** | |
| | (0.053) | (0.050) | | | (0.028) | |
| Exp Lib (n. of PTAs) | | | -0.025 | 0.001 | | -0.031** |
| | | | (0.032) | (0.034) | | (0.015) |
| Imp Lib (n. of PTAs) | | | -0.072*** | -0.069*** | | -0.030** |
| | | | (0.025) | (0.025) | | (0.012) |
| Ln(tariff+1) | -0.119*** | -0.092*** | -0.117*** | -0.091*** | -0.038*** | -0.037*** |
| | (0.022) | (0.023) | (0.022) | (0.023) | (0.007) | (0.007) |
| PTA dummy | -0.052 | -0.052 | -0.043 | -0.050 | -0.075*** | -0.064*** |
| | (0.036) | (0.038) | (0.040) | (0.042) | (0.013) | (0.014) |
| Distance (ln) | -0.876*** | -0.894*** | -0.877*** | -0.895*** | | |
| | (0.034) | (0.036) | (0.034) | (0.036) | | |
| Colony | 0.176** | 0.161** | 0.178** | 0.161** | | |
| | (0.074) | (0.076) | (0.074) | (0.076) | | |
| Common Language | 0.242*** | 0.242*** | 0.242*** | 0.242*** | | |
| | (0.037) | (0.038) | (0.037) | (0.038) | | |
| Contiguity | 0.149** | 0.144** | 0.149** | 0.144** | | |
| | (0.058) | (0.059) | (0.058) | (0.059) | | |
| Fixed Effects: | | | | | | |
| Exp Country | yes | yes | yes | yes | no | no |
| Imp Country | yes | yes | yes | yes | no | no |
| Sector | yes | yes | yes | yes | no | no |
| Year | yes | yes | yes | yes | yes | yes |
| Country pair-by-sector | no | no | no | no | yes | yes |
| Sample | Full | Only Manufacturing | Full | Only Manufacturing | Full | Full |
| Observations | 490,258 | 396,799 | 490,258 | 396,799 | 485,150 | 485,150 |

All specifications include per capita GDP and remoteness for both exporting and importing countries

Standard errors in parentheses are clustered at country pair. *** $p < 0,01; * * p < 0,05; *p < 0,1$.

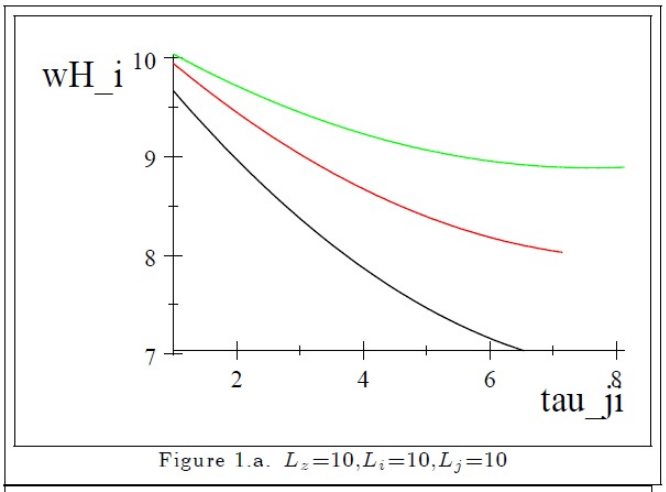


Figure 1.a. $L_z$=10,$L_i$=10,$L_j$=10

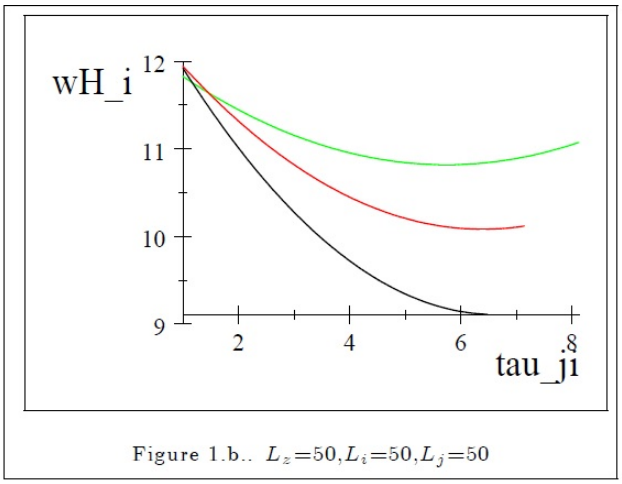


Figure 1.b.. $L_z$=50,$L_i$=50,$L_j$=50

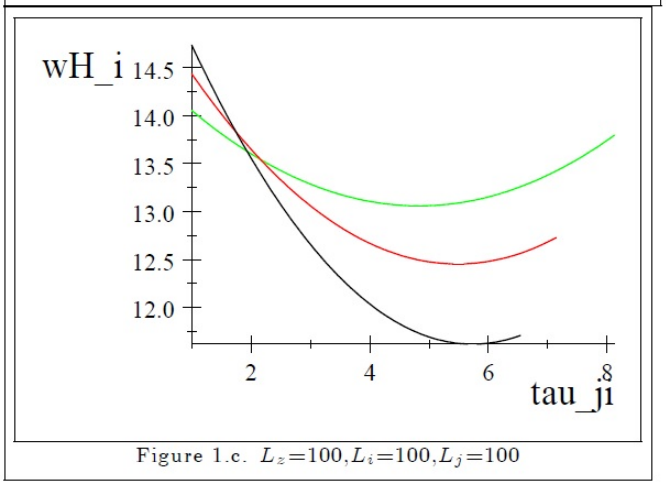


Figure 1.c. $L_z$=100,$L_i$=100,$L_j$=100

black lines: $H_i = 10, H_j = 20, H_z = 30$
red lines: $H_i = 20, H_j = 20, H_z = 20$
green lines: $H_i = 30, H_j = 20, H_z = 10$

Figure A1: Simulation of impact of tariff reductions on skilled workers' wages in $i$.

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