Tariff reductions, trade patterns and the wage gap in a monopolistic competition model with vertical linkages*

Francesco Di Comite† Antonella Nocco‡ Gianluca Orefice§

In this paper we develop a three-country monopolistic competition model with variable elasticity of substitution and vertical linkages to study the impact of trade liberalization on trade creation, trade diversion and labor market outcomes. This framework allows us to identify a source of gain from trade often neglected in the literature: cost savings on capital investments. Our model is empirically motivated by the observation that trade liberalization stimulates trade between the integrating countries and diverts it away from third countries, but it is not associated with increases in exports towards the excluded countries. As for the labor market, trade liberalization is expected to: (i) lower unskilled employment in country-sectors with low export intensity and (ii) to increase the wage gap between skilled and unskilled workers. Trade liberalization is also expected to raise welfare. We test the model's predictions using a dataset on bilateral export flows from 17 OECD exporting countries towards 122 importing countries over the period 1996 to 2007. Our empirical analysis provides results in line with the theory and vindicates the inclusion of vertical linkages in future assessments of the impact of trade liberalization on trade flows, labor markets and welfare.

JEL codes: F12 - F16 - J31

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

*We thank participants of the ITSG workshop (EUI, Florence), LEO Seminar (University of Orleans), CEPII seminar and the workshop "General Equilibrium Dynamics, Market Structure and Trade" jointly organized by the University of Salento, the University of Southern Denmark and DEGIT (Lecce 10-11 October 2013). We are also grateful to Stefano Bolatto, Matthieu Crozet, Mauro Lanati, Daniel Mirza and Thierry Mayer for useful comments and suggestions. The views expressed are purely those of the authors and may not under any circumstances be regarded as stating an official position of the institutions they are affiliated to.

†Department of Economics (IRES), Université Catholique de Louvain; European Commission, DG Joint Research Centre, Calle Inca Garcilaso 3, 41092 Sevilla, Spain - Email: francesco.di-comite@ec.europa.eu .

‡University of Salento, Department of Management, Economics, Mathematics and Statistics, Ecotekne, via Monteroni, 73100 Lecce (Italy) - Email: antonella.nocco@unisalento.it .

§CEPII, 113 rue de Grenelle, Paris - Email: gianluca.orefice@cepii.fr .

1 Introduction

Preferential Trade Agreements (PTAs) are back. After two decades of impasse in multilateral negotiations, developed countries are turning again towards bilateral trade agreements. Since the global trade talks started in Doha in 2001, PTAs have mostly involved developing countries (World Trade Report, 2011, chapter II.B), but the recent signing of the EU-South Korea Free Trade Agreement (in 2011) and the start of official talks on Japan-EU, Canada-EU, and US-EU trade agreements among others, are reigniting the debate, notably on two aspects. The first concerns jobs and wages: what happens in the integrating countries' labor markets? What are the consequences of PTAs on the relative wage of skilled to unskilled workers, i.e. the *skill premium*? The second is on the implications for the countries excluded from the agreements: how are their welfare and trade performance affected? To address these two issues, in this paper we develop and test 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.

The implications of Preferential Trade Agreements on welfare, trade flows, and labor market have been analysed in a vast and growing amount of literature. In particular, the interest on the labor market effects of PTAs had a sudden increase in the last years.[1] The common approach in studying the labor market impact of PTAs is to extend the standard *HO mechanism* by introducing heterogeneity in the productivity across producers within sectors, with skill bias technology at firm level (Burstein et al 2012). The second approach is to introduce capital stock accumulation and capital-skill complementarities into an augmented Ricardian comparative advantages framework (Burstein, Cravino and Vogel, 2013, Eaton and Kortum, 2002, Krusell, Ohanian, Ríos-Rull and Violante, 2000). In these models, capital equipment imports alter the ratio of skilled-to-unskilled labor marginal productivity and hence the wage gap (or, similarly, the 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.[2]

We keep the focus of this literature, but depart from it in the definition of the model setting because of

[1] Previously, the effect of reductions in trade costs was analysed through the standard HO mechanism: reductions in trade cost shift factor 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 HO framework as Mexico has comparative advantage in unskill intensive goods. Similarly, Goldberg and Pavnick (2007) find that skill premium increased also in unskilled workers abundant countries.

[2] 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).

the empirical observation that exports from integrating countries towards third countries are not affected by trade liberalization, which would be inconsistent with standard Ricardian trade models with skill-biased technology. However, we do observe that trade liberalization between two countries affect imports from third countries. 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 (Melitz and Ottaviano, 2008). In such a framework, a new source of gains from trade is identified: savings on the fixed costs of capital investments. Entrepreneurs are indeed assumed to be able to substitute the 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 freed resources can then be used to remunerate the fixed factor (skilled labor). The implications of this modeling choice on the skill premium in terms of wage gap and unskilled workers' employment are similar to those resulting from models based on a skill-biased technology mechanism, but our framework implies a different reaction of trade patterns to changes in bilateral trade costs (that we test here). Using EU KLEMS data on wage and employment level by education attainment for a set of OECD countries in the period 1996-2007, we test the implications of the model and find indeed that the wage gap does increase as a consequence of greater trade openness (measured as a decrease in average trade barriers vis-à-vis the rest of the world) and that the relative employment of unskilled workers decreases in country-sectors which are not enough export-oriented. The negative effect of tariff reduction on unskilled employment is offset in sectors with more that 33% export intensity (as share of sector specific export over total export by country).[3]

In order to motivate our theoretical assumptions (i.e. the departure from the skill biased technology mechanism), we need to show that bilateral trade liberalization boosts trade among liberalizing countries, diverts trade from the excluded country and does not increase exports from liberalizing toward excluded country. Thus our first empirical focus is on the impact of PTAs on trade flows. This issue has been extensively studied in the literature with a particular focus on welfare implications (see Bhagwati, 1993, or Viner, 1950) and on the trade creation effects (Soloaga and Winters 2001; Baier and Bergstrand 2007; Silva and Tenreyro 2006; Egger 2004). Using highly disaggregated bilateral trade data from BACI for a set of 17 exporting and 122 importing countries from 1996 to 2007, we find that, in line with most of the literature, reductions in trade barriers are indeed associated with trade creation between the countries involved, and

[3]In our sample such circumstances are quite rare. For example, it the case for electrical equipment in Japan or non metallic mineral products in Korea.

with trade diversion from excluded country (Romalis, 2007, Frankel, Stein and Wei, 1996, Levy, 1997, Bagwell and Staiger, 1999). However, in line with our theoretical assumptions, we find that bilateral trade liberalization does not imply any increase in the export flows to the excluded country. In other words, the integrating countries trade more with each other (trade creation) and import less from third countries (trade diversion), as generally expected, but do not export more to third countries.

This local pro-competitive effect of trade liberalization, as captured by the decrease in values and volumes of imports from third countries, combined with the absence of effects on exports to third countries, strongly supports the choice of adopting a variable-elasticity-of-substitution framework (in the form of a quadratic utility yielding endogenous markups) with market segmentation and some degree of substitutability between intermediate inputs and fixed capital investments.[4] This functional form displaying pro-competitive effects has been employed by Melitz and Ottaviano (2008) to study theoretically the impact of preferential trade liberalization on welfare. Starting from a situation with three symmetric countries, they find that liberalizing countries experience static and dynamic welfare gains, whereas the excluded third suffers from dynamic welfare losses because of a shift in the pattern of entry.

Given our interest in labor market outcomes, we depart from Melitz and Ottaviano (2008) in including vertical linkages into the picture. Similarly to Picard and Tabuchi (2013), for the sake of tractability, the same functional form used to capture consumer preferences describes also the cost savings function.[5] 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 to save on 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. Notice that our framework is different from purely theoretical New Economic Geography models with vertical linkages à la Krugman and Venables (1995) or Melitz and Ottaviano (2008) because, to ensure empirical tractability, we focus on the static properties of the model and thus assume the

[4] We choose to work with a quadratic utility function because it yields market-specific mark-ups and prevents trade patterns from being altered due to income effects. Notice that, as opposed to a CES utility function where income in directly accounted for, in our framework changes in workers' real income are driven by the evolution of price indices in the different regions. Explicitly accounting for income effects would make the problem less analytically tractable and we leave it for future research.

[5] Picard and Tabuchi (2013) extend the endogenous mark-ups setup with the linear demand system developed by Ottaviano, Tabuchi and Thisse (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.

number of firms in each country to be fixed and proportional to the number of its skilled workers (i.e., it is 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).[6]

Summing up, empirically we find that bilateral trade liberalization (i) increases trade flows between the countries involved; (ii) reduces exports from the excluded country towards the integrating ones; (iii) leaves exports flows toward the excluded countries unaffected.[7] Setting up a new trade model to account for these empirical features, we derive and test the two following properties on the impact of trade liberalization on the labor market: (iv) a decrease in trade barriers is expected to affect negatively employment levels of unskilled workers in country-sectors not enough export oriented and (v) an increase the wage gap between skilled and unskilled workers.

In the process we also find an interesting welfare implication of PTAs. Since trade liberalization is expected to lower imported goods' prices as compared to the unskilled workers' wage (used as the numéraire) and to increase skilled workers' wages; consumers in the integrating regions experience improvements in their welfare that exceeds the welfare losses incurred by the excluded country (whose only sources of loss are the profits shifted towards the integrating countries due to trade diversion). This result has to be taken *cum grano salis*, indeed has not been empirically tested here; nevertheless it contributes to the long-standing debate on regionalism vs multilateralism welfare effects (see Krishna and Panagariya, 2002, or Bhagwati, 1993), by confirming that under certain conditions bilateral trade liberalization is expected to be locally welfare improving and may even be globally beneficial.

Finally, as for the main empirical contribution of this paper on the analysis of the labor market impact of trade liberalization, it should be noted that we move beyond the single country analysis by working on a panel including developed and developing countries through the last three decades, where the effects on importers and exporters are clearly distinguished. To the best of our knowledge, existing literature focuses solely on single country studies to assess the labor market effect of trade liberalization (see Feenstra, 2000, Attanasio, Goldberg and Pavnik, 2004, Goldberg and Pavnik, 2005, Gonzaga, Filho and Terra 2006, Amiti

[6] 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)

[7] Notice that in the context of an imperfect competition model, the concept of trade diversion has to be slightly adapted from the traditional definition of a shift of production from a lower-cost nonmember source to a higher-cost member source (Viner, 1950). As remarked by Bhagwati, Krishna and Panagariya (1999), "a more general definition of trade diversion would not involve identical products, and it would not require any particular differences in costs" but it would rather reflect a distortion of price signals that incorrectly reflect costs and affect consumption patterns.

and Davis 2011, Amiti and Cameron, 2012).[8] 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 introduces the theoretical model and derives the equilibrium results to be tested. In section 3 we describe our empirical strategy to test the model; in particular the trade related tariffs' and PTAs' effects (section 3.1.1) and the labor market related effects (section 3.2.2). In section 4 we show econometric results. Section 5 concludes.

2 The model

We 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_s 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 that, for ease of exposition, will be presented without referring to the location of consumers and producers.

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

2.1 The demand side

The preferences of each individual ζ are represented by the following quadratic utility function à la Ottaviano, Tabuchi and Thisse (2002):

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

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

$$\int_{s \in N} p_s q_s^\zeta ds + q_0^\zeta = w^\zeta + \bar{q}_0^\zeta \tag{2}$$

where p_s is the price of variety s, w^ζ 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 (1) subject to (2) yields the following representative consumer ζ demand function:

$$q_s^\zeta = \frac{\alpha}{(\beta + \gamma N)} - \frac{1}{\beta} p_s + \frac{\gamma}{\beta (\beta + \gamma N)} P \tag{3}$$

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 (3). 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, 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 $q_s = 0$.

2.2 The supply side

In the competitive sector, one unit of the homogeneous good is produced with one unit of unskilled labor. Since the homogeneous good is assumed to be freely traded, we use this good as the numéraire and 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_s units of unskilled labor at the prevailing unskilled labor wage to produce one unit of the good and it incurs in 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 the capital acquired by the firm costs K units of the 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 cost of physical capital or operation: thus, physical capital and intermediate goods are input substitutes.[9] 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 modeled employing the same functional form as the composite good in the consumers' preferences, that is

$$C(q_x^\iota, x \in N) = \alpha \int_{x \in N} q_x^\iota dx - \frac{1}{2}\beta \int_{x \in N} (q_x^\iota)^2 dx - \frac{1}{2}\gamma \left(\int_{x \in N} q_x^\iota dx \right)^2 \tag{4}$$

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 (4) 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

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

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

[9] 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.

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 (3) and it is given by

$$q_x^{\iota} = \frac{\alpha}{(\beta + \gamma N)} - \frac{1}{\beta} p_x + \frac{\gamma}{\beta (\beta + \gamma N)} P \tag{5}$$

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

$$F = K - S[p(.)] + hw^H \tag{6}$$

where w^H is the unit wage of skilled workers and $S[p(.)]$ are the cost savings due to the use of intermediates and they are given by

$$\begin{aligned} S[p(.)] &= \frac{\alpha^2}{2(\beta + N\gamma)} N - \frac{\alpha}{\beta + N\gamma} \int_{x \in N} p_x dx + \\ &\quad - \frac{\gamma}{2\beta (\beta + N\gamma)} \left(\int_{x \in N} p_x dx \right)^2 + \frac{1}{2\beta} \int_{x \in S} (p_x)^2 dx \end{aligned} \tag{7}$$

2.3 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

$$q_{s,rv} = q_{s,rv}^{\zeta} (L_v + H_v) + q_{s,rv}^{\iota} M_v \tag{8}$$

where $q_{s,rv}^{\zeta}$ and $q_{s,rv}^{\iota}$ respectively denote the demand per consumer and firm located in country v for the production of firm s located in country r, and M_v represents the number of firms producing in v. Moreover, given that h units of skilled workers are employed as a fixed input to produce each variety and since we

assume that there is full employment of all workers, the number of firms in country v is

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

This implies that the price index of differentiated goods in country v is

$$P_v = \int_{x \in N_v} p_{x,rv} dx = \frac{H_i}{h} p_{iv} + \frac{H_j}{h} p_{jv} + \frac{H_z}{h} p_{zv} \tag{9}$$

Finally, given that all firms 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 which produces in r are obtained by adding operating profits which 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

$$\pi_{s,rv} = (p_{s,rv} - \tau_{rv} c_s) \, q_{s,rv} \tag{10}$$

where $\tau_{rv} > 1$ represents the role of iceberg trade costs: each firm producing in r has to send τ_{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 internal trade costs within a country. We also assume that $\tau_{rv} = \tau_{vr}$. Hence, markets are segmented and each firm can sell its product at different prices in different markets.

Then, making use of (10) and (6), pure profits π_r of firm s which produces in country r are

$$\pi_{s,r} = \pi_{s,ri} + \pi_{s,rj} + \pi_{s,rz} - F_{s,r} \tag{11}$$

where minimized fixed costs in r, $F_{s,r}$, can differ across the three countries for firms having the same marginal cost c_s 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 clearly equal to the price of consumption goods available in r), that is $P_r = \int_{x \in N_r} p_{x,vr} dx$.

In equilibrium, firms earn zero profits and this implies that using (11), the unit wage paid by each firm s at location r to skilled workers should be equal to

$$w_r^H = \frac{\pi_{ri} + \pi_{rj} + \pi_{rz} - K + S[N_r, P_r]}{h} \tag{12}$$

Markets are segmented and each firm s producing in r sets its price for market v by

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

subject to its demand function in v

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

obtained substituting (3) and (5) into (8). Thus, the price set in market v by firm s producing in r is

$$p_{s,rv} = \frac{1}{2}\tau_{rv} c_s + \frac{\alpha\beta + \gamma P_v}{2\,(\beta + \gamma N_v)} \tag{13}$$

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

$$q_{s,rv} = \frac{(L_v + H_v + M_v)}{\beta}\,(p_{s,rv} - \tau_{rv} c_s) \tag{14}$$

and maximized profits are

$$\pi_{s,rv} = \frac{(L_v + H_v + M_v)}{\beta}\,(p_{s,rv} - \tau_{rv} c_s)^2 \tag{15}$$

We can substitute prices from (13) in (9) together with the assumption that c_s and N are common to all countries to get

$$P_v = \frac{N \frac{\alpha\beta}{2(\beta+\gamma N)} + \frac{1}{2}\delta_v c_s}{1 - \frac{\gamma N}{2(\beta+\gamma N)}} \tag{16}$$

where $\delta_v = M_i \tau_{iv} + M_j \tau_{jv} + M_z \tau_{zv} = \frac{H_i}{h}\tau_{iv} + \frac{H_j}{h}\tau_{jv} + \frac{H_z}{h}\tau_{zv}$.

Making use of (14), (13) and (16), we get that local sales of a firm producing in i are

$$q_{s,ii} = \frac{L_i + H_i + M_i}{\beta}\left[\alpha \frac{\beta}{2\beta + \gamma N} + \frac{1}{2}\gamma c_s \frac{H_j \tau_{ji} + H_z \tau_{zi}}{(2\beta + \gamma N)\, h} - \mu_{ii} \frac{1}{2} c_s\right] \tag{17}$$

where $0 < \mu_{ii} = 1 - \frac{\gamma H_i}{h(2\beta+\gamma N_i)} = 1 - \frac{\gamma M_i}{(2\beta+\gamma N_i)} < 1$, while its exports in country j are

$$q_{s,ij} = \frac{L_j + H_j + M_j}{\beta}\left[\alpha\frac{\beta}{2\beta+\gamma N} + \frac{1}{2}\gamma c_s\frac{H_j + H_z\tau_{zj}}{(2\beta+\gamma N)\,h} - \mu_{ij}\frac{\tau_{ij}}{2}c_s\right] \tag{18}$$

with $0 < \mu_{ij} = 1 - \frac{\gamma\frac{H_i}{h}}{2\beta+\gamma N_j} < 1$ as $\frac{H_i}{h} = M_i < N_j$. Moreover, from expression (18) we get that exports to country z of a firm producing in i are

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

where $0 < \mu_{iz} = 1 - \frac{\gamma H_i}{h(2\beta+\gamma N_z)} < 1$. Thus, it is readily verifiable from (18) that the quantities exported by firms in i towards j , $q_{s,ij}$, increase if τ_{ij} decreases and decrease if τ_{jz} decreases, while they are not affected by a reduction in τ_{iz} . This observation entails the following empirically testable propositions:

Proposition 1 (trade creation): a decrease in trade barriers between country i and j is expected to increase their bilateral trade flows;

Proposition 2 (no increase in exports to third countries): a decrease in trade barriers between country i and j does not increase the exports of i to a third country z;

Proposition 3 (trade diversion): a decrease in trade barriers between country i and j is expected to decrease the imports of i from a third country z.

Propositions 1 and 3 are standard in the literature on trade creation and diversion. Bilateral trade liberalization (here assumed as 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 is the economic rationale for Proposition 2. 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 use cheaper intermediates to substitute physical capital and being more competitive in exporting toward the excluded country z. In our theoretical model this is not the case because the use of intermediate inputs reduces firms' fixed costs leaving unchanged the operating profit of firms localized in i and j. This is a crucial modelling choice to be tested in the empirical section of this paper.

At first sight, the second and the third propositions may appear counterintuitive and specific of the model under consideration. Yet, they just stem from two rather simple and common assumptions: market segmentation and pricing-to-market behavior. The 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). The latter assumption derives from the consideration that firms always charge the profit-maximizing prices in the markets where they ship their products and ensures that no changes are expected in quantities or prices of shipments to market z if non changes are observed in its market aggregates. The combination of these two assumptions then explains why, after all, *Proposition 2* and *3* are in line with our a priori expectations of the model.

Turning to the labor market outcomes, one additional proposition may be derived from the previous equations. Noting that unskilled workers are employed proportionally to the quantities produced, it can be noted from (17) and (18) 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. Even if the overall effect depends on the values of the parameters of the model, the following propositions can be tested on the total employment:

Proposition 4 (employment loss on the domestic segment): a decrease in the trade barriers faced by country i is expected to decrease the employment levels of unskilled workers producing in i for the domestic market.

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.

Making use of (13), (15) and (16), maximized profits of a firm producing in i from local sales and exports in country j and z are respectively given by

$$\pi_{s,ii} = \frac{(L_i + H_i + M_i)}{\beta} \left[\alpha \frac{\beta}{2\beta + \gamma N} + \frac{1}{2} \gamma c_s \frac{H_j \tau_{ji} + H_z \tau_{zi}}{(2\beta + \gamma N)\, h} - \mu_{ii} \frac{1}{2} c_s \right]^2 ; \tag{19}$$

$$\pi_{s,ij} = \frac{(L_j + H_j + M_j)}{\beta}\left[\alpha\frac{\beta}{2\beta+\gamma N} + \frac{1}{2}\gamma c_s\frac{H_j + H_z\tau_{zj}}{(2\beta+\gamma N)\,h} - \mu_{ij}\frac{1}{2}\tau_{ij}c_s\right]^2 \tag{20}$$

and

$$\pi_{s,iz} = \frac{(L_z + H_z + M_z)}{\beta}\left[\alpha\frac{\beta}{2\beta+\gamma N} + \frac{1}{2}\gamma c_s\frac{H_z + H_j\tau_{jz}}{(2\beta+\gamma N)\,h} - \mu_{iz}\frac{1}{2}\tau_{iz}c_s\right]^2 \tag{21}$$

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 the higher the number of firms producing abroad. The opposite is true of profits obtained from exports, which increase when the bilateral trade barriers with the trade partner are lowered. However, consistently with Proposition 3, the effect of 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.

Expressions (19), (20) and (21), together with the expression for $S[N_i, P_i]$ can be substituted into (12) to get w_r^H.

Using (16) and the following expression

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

we can rewrite $S[N_i, P_i]$ as follows

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

which depends on τ_{ij} and on τ_{iz}, while it is not affected by τ_{jz}.

Turning our attention to the wage of skilled workers in i, numerical analysis show that w_i^H increases if τ_{ji} or τ_{zi} decrease. For instance, Figure 1 shows that w_i^H increases if τ_{ji} decreases.[10] It is so because total firms' profits increase as a consequence of lower cost of intermediates $S[N_r, P_r]$ in (7). At first sight, this finding may appear in contradiction with *Proposition 2* or equation (20), in which τ_{zi} is shown to have no impact on π_{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 (19), (20) and (21) refer to operating profits, whereas skilled worker wages are paid from total profits, which benefit from the reduction in fixed

[10] The graphic is obtained for $\tau_{jz} = 4$, $\alpha = 10$, $h = 1$, $H_i = 10$, $H_j = 20$, $H_z = 30$, $\beta = 2$, $c = 0.1$, $\gamma = 2$, $\tau_{zi} = 3$, $L_z = 10$, $L_i = 10$, $L_j = 10$ and $K = 10$.

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 5 (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 .

Bilateral liberalization between country i and j makes imported intermediate inputs cheaper and thus reduce the fixed cost 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 scarce factor remunerated from total profits (zero profit condition), the wage of skilled workers increases while the wage of unskilled remains unchanged. That's how bilateral trade liberalization affects the skill premium in this model.

2.4 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 (1) can also be used to draw the indirect utility functions capturing the welfare of consumers in the three countries considered:

$$\begin{aligned} W &= \frac{\alpha^2 N}{2(\beta+\gamma N)} - \frac{\alpha}{\beta+\gamma N}\int_{s\in N} p_s ds + \frac{\int_{s\in N}(p_s)^2 ds}{2\beta} \\ &\quad -\frac{\gamma}{2\beta(\beta+\gamma N)}\left(\int_{s\in N} p_s ds\right)^2 + w + \overline{q}_0, \end{aligned} \tag{22}$$

from which it can be noted that[11]

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

Combining this result with the impact on prices, from equations (13) and (16), and the impact on profits and skilled workers' wages, from equations (19), (20) and (21), 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

[11] The sign of the first derivative is negative as this is consistent with a positive value of quantities in (3).

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 (20) it can be noticed that the increase in export profits and high skilled workers' salaries in the integrating countries are bound to be higher than the loss of export income in the excluded country. Therefore our model suggests that even a bilateral PTA could be associated with static global welfare gains. Indeed, consumers in the integrating regions 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.

3 Empirical strategy

As highlighted in the previous section, the labor market predictions are strictly related with the trade outcomes. Indeed, if confirmed by data, the absence of any export increasing effect of bilateral trade liberalization from liberalizing towards excluding country -*Proposition*2 - represents an important validation of the theoretical assumption according to which vertical linkages affect only the fixed side of the firm's cost structure; which is in turn a crucial assumption for the wage gap effect of trade liberalization. In this perspective, trade related estimations are almost meant to support our modelling choices, while labor market estimation are primarily intended to test model's predictions.

For this reason trade and labor market empirical tests are intimately related and have to be presented subsequently. Thus, for exposition purposes, in this section we present first the empirical strategy used to test theoretical predictions (1) -(3) - trade related predictions - and then we focus on labor market theoretical predictions (4) and (5) - labor market related predictions.

For the empirical part of this paper we use a comprehensive dataset containing information on trade liberalization, trade flows, wage and employment by skill level. The first three propositions are addressed using an augmented gravity equation (Anderson and Van Wincoop 2003; Baier and Bergstrand 2007; Head and Mayer 2013), while propositions 4 and 5 are tested following some existing studies on wage premium estimation (Revenga 1997; Attanasio, Goldberg and Pavnik 2004; Goldberg and Pavnik 2005).

3.1 Data

For our empirical analysis we combine two main datasets, one on trade flows and the other on wage and employment by skill level. Trade data come from BACI (CEPII), which includes values and quantities of export flows (in USD and tons respectively) for a complete set of exporting and importing countries in the period 1989-2007 [12] - however our final sample shrinks to the period 1996-2007 because of tariff data availability and to only OECD exporter countries to be coherent with data on labor market outcomes (while the set of importing country remains unchanged). Tariff data are from TRAINS dataset and refer to applied tariff level imposed by each importing country on a specific sector.[13]

Although BACI provides trade data at product level (classification HS-6 digit) we aggregated them at ISIC 2-digit industry level in order to match it with labor market dataset. Labor market data come from EU KLEMs dataset[14] reporting information on wage and employment level by skill group (primary, secondary and tertiary education).[15] 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.

Our main proxy for trade liberalization is based on the applied bilateral tariff level from TRAINS; however, we also use a Preferential Trade Agreement dummy (PTA) to capture the effect of trade liberalization. The PTA dummy variable is based on a comprehensive list of PTAs in force based on data available on the WTO website; and is equal to one if a country pair share a common PTA at time t.

[12] The dataset includes observations up to 2010, but we use the trade only up to 2007 to get rid of the highly volatile observations during the recent crisis.

[13] Tariff data at HS-2 digit have been converted into ISIC classification in order to be coherent with the sector classification of labor market related variables.

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

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

Other variables come from standard sources: (i) geographic variables (such as distance) come from CEPII dataset;[16] (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.

3.1.1 Trade related estimations

The empirical strategy to test propositions (1) - (3) relies on the standard augmented gravity model (Anderson and van Wincoop 2003; Silva and Tenreyro 2006; Head and Mayer 2013). Highly disaggregated data from BACI allow us to estimate the trade creation (*Proposition 1*), diversion (*Proposition 3*) and the pro-competitive effect (*Proposition 2*) at sector (ISIC) level for a set of 17 exporting, 122 importing countries, 35 sectors in the period 1996-2007. In particular we run the following regression:

$$y_{i,j,s,t} = \phi_{it} + \phi_{jt} + \phi_{st} + \beta_1 Log(Tariff + 1)_{ijst} + \beta_2 PTA_{ijt} + \beta_3 X_{ij} + \varepsilon_{ijst} \tag{23}$$

where subscripts i, j, s and t stand respectively for exporter, importer, sector ISIC and year. Following the theoretical model presented in the previous section, our dependent variable $y_{i,j,s,t}$ is the quantity exported by country i to j in sector s at time t. However, as a robustness check, we replicate our estimations also on export values.

The crucial explanatory variables capturing bilateral trade liberalization (as suggested in the theoretical model) are in turn: (i) the bilateral sector-specific applied tariff level in log $(Tariff_{ijst} + 1)$, and (ii) Preferential Trade Agreement dummy being equal to one if country i and j share a PTA at time t (PTA_{ijt}).

The vector of control variables X_{ij} includes geographic variables traditionally used in estimating structural gravity models to predict trade flows. Such control variables set includes: (i) distance (in ln), (ii) common border, (iii) language and (iv) past colonial linkages.

Finally, we include three sets of fixed effects to control for several country-year (ϕ_{it}, ϕ_{jt}) and sector-year (ϕ_{st}) specific factors affecting trade but not explicitly included in equation [23]. Country-year fixed effects capture country specific macroeconomic dynamics (such as GDP, population, etc.), but also control for some

[16] Mayer and Zignago (2011).

variables deriving from the theoretical model, such as the number of firms producing in each country (M_v), the number of high (H_v) and low (L_v) skilled workers available in the country at time t. More importantly, country-year fixed effects are meant to capture the multilateral resistance term as in Baier and Bergstrand (2007) and Head and Mayer (2013). Sector-year fixed effects capture any potential technological shock in a given sector affecting trade dynamics.

As robustness check, we use a three-way fixed effects specification including country-sector-time fixed effects. This specification is meant to further control for the multilateral resistance term.[17] Unfortunately, this last specification could be ran only using linear model[18], since PPML (which however remains our preferred estimator) with such a big number of fixed effects would suffer a huge incidental parameter problem (see Charbonneau 2012) and would not be feasible for computational reasons.[19] For this reason, linear estimation with country-sector-year fixed effect constitutes here only a robustness check and for this reason reported in the appendix section.

To test Propositions 2 and 3 we need two additional variables. *Proposition* 2 suggests that the bilateral reduction of trade cost between country i and j does not affect exports by i towards the excluded country z (no pro-competitive effect). To fit such proposition in the empirical framework where the dependent variable is ij specific, we can rephrase the proposition saying that bilateral liberalization iz does not affect export flows from country i to j.

Proposition 3 predicts the traditional trade diversion effect: the country excluded from the bilateral liberalization will face a reduction in its exports; i.e. if the partner country j signs a PTA with a third country z, we expect a reduction in the export flows from i to j.

Thus we need one variable capturing the changes in trade costs between the exporter i and the rest of the world (z); and another variable capturing the changes in trade costs between the importer j and the rest of the world. In finding these variables we draw from the existing literature on trade diversion (see Gosh and Yamarik 2004; Baldwin and Jaimovich 2012). We use two dummy variables; the first being one if the exporter has at least a PTA with the rest of the world (*ExpLiberalization* to test *Proposition* 2); the second dummy has the same logic but from the perspective of the importer country (*ImpLiberalization* to test *Proposition* 3). When the exporter country liberalizes trade with country z, we do expect any change in the

[17] Country-Sector-Year fixed effects control also for the comparative advantage of each country in given sector.

[18] Specifically we use the Guimaraes Portugal (2010) estimator.

[19] PPML with country-sector-year fixed effects would imply the introduction of 58380 dummy variables which would not be possible for computational problems in STATA.

export flow from i to j - no pro competitive effect - and thus a null coefficient for $ExpLiberalization$. When the importer country liberalizes trade with country z, we expect country j importing less from country i. Thus we expect a negative coefficient for $ImpLiberalization$.

Since these two measures are country-year specific, in the empirical specifications testing proposition (2) and (3) we cannot include country-year fixed effect (because of perfect collinearity) which are replaced by simple country fixed effects. Sector-year fixed effects still included. Thus, to test propositions 2 and 3 we rely on the following empirical model:

$$\begin{aligned} y_{i,j,s,t} &= \phi_i + \phi_j + \phi_{s,t} + \beta_1 Log(Tariff + 1)_{ijst} + \beta_2 PTA_{ijt} + \beta_3 ExpLiberalization_{it} + \\ &\quad \beta_4 ImpLiberalization_{jt} + \beta_5 X_{ijt} + \varepsilon_{ijst} \end{aligned} \tag{24}$$

where $Tariff_{ijst}$ and PTA_{ijt} have the same meaning as in the previous specification (i.e. applied tariff level and PTA dummy). The new crucial variables in specification (24) are $ExpLiberalization_{it}$ and $ImpLiberalization_{jt}$; they are dummy variables equal to one if respectively exporter and importer country has a PTA in force with at least one third country (z).

Since country-year fixed effects have to be dropped, the set of control variables X_{ijt} in equation (24) has been augmented to control for the multilateral resistance term and other country-year specific factor affecting trade. To 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.[20] Then we include the price index in both exporter and importer country to control for the price level dynamics in the two countries.[21] The set of control variables includes also per capital GDP in both exporter and importer country.

The first econometric issue concerning equations (23) and (24) is the potential endogeneity due to both reversal causality and omitted variable problems. The omitted variable problem is crucially reduced by the inclusion of a huge set of fixed effects and control variables, which captures all the variables potentially affecting trade flows.

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

[21] The price index has been computed as the country specific mean of Real Exchange Rates (with its trade partner), weighted by the share of trade of each country with its trade partner. We strictly followed the procedure used in Berman, Martin and Mayer (2012).

Although the strict exogeneity test reported in Table (2) suggests few concerns of reverse causality[22] some concerns remain. Indeed, countries can sign a PTA to secure their current level of trade with an established trade partner or importer country j might increase tariff protection because of huge imports from i. For these reasons we also use an instrumental variable approach.

To instrument the PTA dummy variable we build on the domino effect in PTAs formation identified by Baldwin and Jaimovich (2012) and Chen and Joshi (2010). The idea is that, the higher the number of PTAs that the exporter i has with the rest of the world, the higher the probability that country j pushes to sign a PTA with i to avoid trade diversion effect. The exclusion restriction here is satisfied if the number of PTAs by exporter country with the RoW does not affect (and is not affected by) export flows towards j. Our theoretical model and empirical results (see Table 1) support this assumption. If the exporter country liberalizes trade with a given country z, we do not observe any change in the export flows from i to j - *Proposition* 2. However, the instrument remains relevant since country j has the incentive to sign a PTA with i to avoid any diversion effect (which is predicted by our model).[23]

Finding a valid and relevant instrument for the tariff level is more complicated.[24] We use the average protection level applied by importer country j (in sector s) with respect to the rest of the world (all countries z but exporter i). This variable is highly correlated with the bilateral tariff level (see 2SLS first stage results in Table A3) and mainly uncorrelated with bilateral trade flows. Indeed, in our view, it is unlikely that country j modifies tariff level against z when changes in j's imports from i are experienced (excluded restriction).[25]

The last econometric issue concerns the zero trade flows problem (Helpman et al. 2008; Silva and Tenreyro 2006); in presence of large number of zeros in bilateral (sector) specific trade flows in the dataset, the log specification implies the drop of these flows and the resulting OLS estimator is biased (i.e. systematic sample

[22] Strict exogeneity test, as in Wooldridge (2002) and Head and Ries 2010, consists in testing whether any "feedback effects" emerges between potentially endogenous and dependent variables. In practice, we include the $future$ tariff level and PTA dummy in equation (23) and (24): if tariff changes and PTA's signature are strictly exogenous to trade flows, $future$ values of tariff and PTA dummy (lead values) should be uncorrelated with the concurrent trade flow. We cannot reject the null of strict exogeneity for all our specifications, with the exception of tariff level in the exported values regressions (see table 2). By including lead PTA dummy we are also test for any potential anticipation effect (as in Baier and Bergstrand 2007)

[23] Since our instrument for PTA is exporter country-year specific we could not include exporter country-year fixed effects in our 2SLS approach; thus we rely on exporter country fixed effect along with importer country-year and sector-year fixed effects. Moreover, since the instrument is exporter-year specific and the dependent variable is country pair-sector-time specific, standard errors have been clustered by exporter country.

[24] Widely used instrument for tariff is the pre-liberalization tariff level (Goldberg and Pavnik 2015; Buono and Lalane 2012); however such instrument is specifically thought for country specific trade liberalization and does not show time variance. Since in our setting we use a panel of country and heavily rely on time variation we decided to abandon this instrument

[25] Since the instrument is importer-sector-time specific and the dependent variable is country pair, sector time specific, standard errors have been clustered by importer-sector.

selection of data) and has heteroskedastic error term (Silva and Tenreyro 2006; Head and Mayer 2013).[26] As a first solution in order to keep zero trade flows, in all our OLS estimations we use the log of trade flow plus one. However such solution is sensitive to the unit of measure and still suffers the heteroskedasticity of the error terms. So here we use this strategy only as a robustness check (results in the Appendix section).

Although there is not a perfect estimator in presence of zero flows, 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). Unfortunately non linear Poisson model, being in levels, over-weighs big observations (Head and Mayer 2013), so we also run, as a last robustness check, a EK tobit estimation which performs well in case of both lognormal and heteroskedastic error term (see Head and Mayer 2013). The EK tobit estimator consists of replacing zeros with the minimum trade flow, taking the log and estimating a tobit using the log of minimum trade as lower limit. This last estimator does not over-weigh big trade flows.

3.1.2 Labor market estimations

Propositions 4 and 5 suggest that a decrease in trade costs due to a reduction in protection by trading partners (or 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 to domestic vs foreign market within the firm; so we can only 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:

$$ln(\frac{Skilled_W age}{Unskilled_W age})_{i,s,t} = \phi_{i,t} + \phi_{s,t} + \beta_1 Log(Tariff + 1)_{i,s,t} + \beta_2 X_{i,s,t} + \varepsilon_{i,s,t} \quad (25)$$

and

$$ln(Unskilled_E mployment)_{i,s,t} = \phi_{i,t} + \phi_{s,t} + \beta_1 Log(Tariff + 1)_{i,s,t} + \beta_2 X_{i,s,t} + \varepsilon_{i,s,t} \quad (26)$$

[26] In our sample we have 4% of zero flows for export values and 1.5% of zeros for exported quantities.

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 in 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 country and sector-year specific characteristics. Country-year fixed effects capture differences in labor market characteristics 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).[27]

In a first set of estimates - robustness, 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.[28] Then, the export intensity 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 intensity, 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.[29]

The export intensity 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 4*). So by interacting the tariff variable with the export intensity 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

[27] Country-Sector fixed effects could not be included since there is not enough time variance in the tariff variable.

[28] 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).

[29] Export intensity also control for the trade specialization (i.e. sector comparative advantage) of the exporter country, which in principle could affect the wage and the employment level in the country.

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. As already noticed, finding a good instrument for tariff level is not easy. The average tariff level faced by each exporter in a given sector used as IV in the previous section cannot be used in the current framework since it is now exactly the variable of interest (the variable to be instrumented). Thus 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 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 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 instruments described above are very correlated with the country-sector specific tariff level suggesting their relevance (see table A4, A5, A6).

4 Main results

For expositional purposes, also in this section the results of the empirical tests are split into two groups. First, we describe the results concerning the impacts of trade liberalization on trade flows (*Propositions* 1, 2, and 3); and then we turn to the labor market outcomes results (*Propositions* 4 and 5).

4.1 Trade flows

The empirical tests for our first three propositions can be found on Table 1, where are shown PPML regressions on traded quantities and values. Robustness checks using simple OLS estimator are shown in Table

A2. Results of the instrumental variable approach (second stage regression) are presented in Table 3 (with first stage results reported in Table A3).

As stated in *Proposition 1 (trade creation),* the consistently negative and significant coefficients on the tariff variable (or a consistently positive sign on the PTA dummy) in almost all the specifications signals that a decrease in trade barriers between country i and j is indeed associated with an increase in bilateral trade flows. Such evidence is robust across all the specifications and econometric models we used (PPML, EK Tobit, 2SLS and OLS).[30] According with our preferred specification PPML with country-year and sector-year fixed effect (column (3) in table 1) having a PTA in common stimulates bilateral trade by 27%. This results may appear consistently smaller with respect other existing studies on this topic (Baier and Bergstrand 2007); but this was expected since in our sample we have only OECD exporting countries; and the effect of PTAs is generally bigger for developing country.

As for *Proposition 2* - predicting no improvement in export flows toward the excluded country - it can be noted that the coefficient associated with the variable "*ExpLiberalization*" is not significant (Table 1 columns 5 and 10), meaning that a trade liberalization agreement between countries i and z does not imply any increase in trade flows between i and j. In other words we find no exports gains toward third countries from bilateral trade liberalization. This would not be consistent with models with an augmented Ricardian framework where imports can be used as variable inputs in the production process, but is consistent with a theoretical model exploiting vertical linkages in which imported inputs are used as substitutes for fixed investment costs. As a caveat on the generality of our results, it should be remembered that our sample is restricted to exports from countries for which we could find reliable labor market data (i.e. the members of the OECD), while there are no restrictions on importers. This means that our results may hold for north-to-south or north-to-north trade but not necessarily for south-to-north or south-to-south, where it may still be possible that importers' marginal costs of production are affected by a reduction in trade barriers (e.g., as a results of trade in semi-finished products), which leaves room for further research.

Finally, *Proposition 3 (trade diversion)* states that a decrease in trade barriers between importer j and a third country z is associated with a decrease in the exports of i to j because of the increased competition of products from z altering the price index in j. The negative coefficients associated with the variable "*ImpLiberalization*" in Table 1 confirm this prediction.

[30] Table A3 suggests the relevance of our instruments in predicting both tariff level and PTA dummy. Indeed coefficients on IV for tariff and PTA are positive and strongly significant with safe F-stat for excluded instruments.

All in all, the main contribution of our analysis in the disentanglement of the impact of trade liberalization on the involved countries' imports and exports to third countries. This new way of looking at the trade creation vs trade diversion issues allows us to confirm the consistence of our modeling choices with the trade data and supports the use of the model to study the labor-market related implications.

4.2 Labor outcomes

To test *Proposition 4* - employment loss on the domestic segment - Tables 4 has to be read in combination with Table 1. In particular, Table 4 shows the results for both OLS and 2SLS estimations on the level of unskilled employment in different sectors.[31]

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 Tables 1 state that a reduction in bilateral trade costs boosts trade and thus increases employment in the export segment, the coefficients in Tables 4 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.[32] The combination of these two results represents a first piece of evidence in favor of *Proposition 4*. Moreover, the negative coefficient of the interacted term between tariff and export intensity suggests that a tariff reduction reduces on average unskilled employment with a lesser extent in high export intensive sector. 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 2.5% reduction in the employment level of unskilled workers in not exporting sectors, which shrinks to a 2.2% 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 33% export intensity (very rare in our dataset).

[31] First stage regression results reported in table A4 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 tables A5 and A6.

[32] As a further robustness check we estimate equation (26) 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.

As for the impact on skilled workers' wages analyzed in *Proposition 5 (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 5 and 6 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 5). 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 6).

Specifically, OLS and 2SLS regressions are run first on the skill premium as the ratio between skilled and unskilled wages (Table 5)[33] and then on the level of skilled workers' wages using unskilled workers' wages as a control (Table 6).

The two sets of regressions yield qualitatively identical results and do not reject the *Proposition* 5: as the trade barriers decrease, the skill premium rises. This result holds statistically significant for a large number of different specifications, with few exceptions. First stage regression results for labor market related 2SLS estimations are reported in Tables A4, A5 and A6.

Summing up, none of the theoretical propositions of the model is rejected from the data, which suggests that the model presented here may be a reasonable framework to study the interactions between vertical linkages and labor markets in a context of reduction of trade protection.

5 Conclusions

In this paper we analyzed the impact of bilateral tariff reductions and PTAs not only on the involved parties but also on third countries. We did so by using a three-country monopolistic competition model with vertical linkages and a labor market differentiated by skill level. Empirical tests of our analytical results seem to confirm that:

- bilateral trade liberalization increases trade flows between the countries involved in the integration process;

[33] Remember we defined as "skilled" the secondary and tertiary educated workers, while we refer as "unskilled" to primary educated workers

- the countries involved in the integration process do not gain a competitive advantage in exporting to third countries;

- the countries involved in the integration process divert trade away from third countries by importing less of their products;

- 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. Theoretically, 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. Empirically, we do observe a stronger decline in unskilled workers' employment following trade liberalization in less export-oriented sectors.

- The skill-driven wage gap within the countries involved in the integration process increases, i.e. the difference in remuneration between skilled and unskilled workers rises as a consequence of reductions in trade barriers.

The paper provides also a little contribution on the welfare effect of PTAs. Since the prices in the integrating countries fall because of the reduction in trade costs and real wages increase, the tariff reduction of PTA can be shown to be locally welfare improving for the participants of the agreements and is likely to be globally welfare improving. This result is theoretically driven 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 as long as the number and location of firms and workers is held fix. A promising future avenue of research would be to investigate the dynamic properties of our model and test whether the results are robust to the introduction of endogenous entry and exit of firms and/or migration 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. Discerning between static and dynamics effects in such an extension of the model, while at the same time empirically validating it, would however not constitute a trivial pursuit.

Tables

Table 1: Trade liberalization and exports (values and quantities) - Poisson

	Exported Quantities					Exported Values				
	Poisson	Poisson	Poisson	EK Tobit	Poisson	Poisson	Poisson	Poisson	EK Tobit	Poisson
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)
Ln(Tariff+1)	-0.044		-0.043	-0.116***	0.006	-0.190***		-0.190***	-0.156***	-0.0912***
	(0.047)		(0.047)	(0.029)	(0.038)	(0.039)		(0.039)	(0.027)	(0.025)
PTA dummy		0.244***	0.244***	0.240***	0.115**		0.065	0.065	0.134***	-0.059
		(0.080)	(0.080)	(0.048)	(0.053)		(0.056)	(0.056)	(0.042)	(0.038)
Distance (Ln)	-1.259***	-1.270***	-1.269***	-1.926***	-1.267***	-0.913***	-0.915***	-0.914***	-1.650***	-0.924***
	(0.051)	(0.051)	(0.051)	(0.041)	(0.053)	(0.037)	(0.037)	(0.037)	(0.036)	(0.038)
Colony	-0.079	-0.037	-0.038	0.654***	-0.141	0.292***	0.302***	0.300***	0.760***	0.200***
	(0.088)	(0.086)	(0.086)	(0.065)	(0.100)	(0.061)	(0.061)	(0.061)	(0.057)	(0.062)
Common Language	0.304***	0.300***	0.301***	0.618***	0.315***	0.377***	0.376***	0.377***	0.653***	0.350***
	(0.050)	(0.050)	(0.050)	(0.034)	(0.051)	(0.034)	(0.034)	(0.034)	(0.030)	(0.036)
Contiguity	0.462***	0.464***	0.464***	0.197***	0.551***	0.160***	0.163***	0.161***	0.172***	0.273***
	(0.073)	(0.072)	(0.072)	(0.065)	(0.080)	(0.053)	(0.053)	(0.053)	(0.057)	(0.057)
ExpLiberalization					-0.029					0.016
					(0.084)					(0.053)
ImpLiberalization					-0.169**					-0.157**
					(0.077)					(0.069)
Fixed Effects:										
Country	no	no	no	no	yes	no	no	no	no	yes
Year	no	no	no	no	yes	no	no	no	no	yes
Country-Year	yes	yes	yes	yes	no	yes	yes	yes	yes	no
Sector-Year	yes	yes	yes	yes	yes	yes	yes	yes	yes	yes
Observations	148,299	148,299	148,299	148,299	142,146	148,299	148,299	148,299	148,299	142,146

Specifications in columns (5) and (10) include also per capita GDP, remoteness and price index for both exporting and importing countries
Standard errors in parentheses are clustered at country pair. *** $p < 0,01; ** p < 0,05; *p < 0,1$.

Table 2: Trade liberalization and exports (values and quantities) - Strict Exogeneity Test

	Exported Values in Ln		Exported Quantities in Ln	
Ln(Tariff+1)	-0.021	-0.021	-0.119***	-0.119***
	(0.019)	(0.019)	(0.021)	(0.021)
PTA dummy	0.123***	0.127***	0.204***	0.216***
	(0.025)	(0.025)	(0.028)	(0.029)
$\text{Ln(Tariff+1)}_{t+2}$	-0.064***	-0.064***	0.010	0.010
	(0.019)	(0.019)	(0.021)	(0.021)
PTA dummy_{t+2}	-0.020	-0.023	0.038	0.029
	(0.031)	(0.031)	(0.035)	(0.035)
Distance (ln)	-1.677***	-1.677***	-1.952***	-1.953***
	(0.014)	(0.014)	(0.016)	(0.016)
Colony	0.243***	0.243***	0.253***	0.253***
	(0.022)	(0.022)	(0.025)	(0.025)
Common Language	0.626***	0.626***	0.527***	0.527***
	(0.0245)	(0.024)	(0.027)	(0.027)
Contiguity	0.676***	0.676***	0.612***	0.612***
	(0.0128)	(0.012)	(0.014)	(0.014)
Diversion Exporter		0.134		-0.255
		(0.272)		(0.239)
Diversion Importer		-0.089		-0.276**
		(0.103)		(0.112)
Observations	123967	123967	118479	118479
R-squared	0.775	0.775	0.747	0.747

Country-period and sector-year fixed effects included

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

Table 3: Trade liberalization and exports (values and quantities) - 2SLS Second Stage Regressions

	Exported Values in Ln			Exported Quantities in Ln		
	(1)	(2)	(3)	(4)	(5)	(6)
Ln(Tariff+1)	-0.293***		-0.293***	-0.238***		-0.238***
	(0.054)		(0.054)	(0.057)		(0.057)
PTA dummy		0.154	0.146*		0.500***	0.479***
		(0.594)	(0.085)		(0.663)	(0.102)
Distance (ln)	-1.636***	-1.642***	-1.643***	-1.898***	-1.916***	-1.920***
	(0.042)	(0.069)	(0.042)	(0.048)	(0.094)	(0.049)
Colony	0.723***	0.743***	0.738***	0.600***	0.656***	0.650***
	(0.060)	(0.230)	(0.060)	(0.066)	(0.230)	(0.065)
Common Language	0.641***	0.645***	0.643***	0.605***	0.612***	0.610***
	(0.033)	(0.060)	(0.033)	(0.038)	(0.069)	(0.028)
Contiguity	0.165***	0.165**	0.164***	0.204***	0.196**	0.200***
	(0.058)	(0.079)	(0.058)	(0.065)	(0.081)	(0.065)
Observations	142301	148299	142301	142301	148299	142301
R-squared	0.748	0.747	0.749	0.742	0.738	0.742

Exporter, Importer-year,sector-year fixed effects included

Cluster standard errors by importer-sector in columns 1.3.4 and 6.

Cluster standard errors by exporter in columns 2 and 5.

*** $p < 0,01; ** p < 0,05; *p < 0,1$.

Table 4: Trade liberalization and the employment of unskilled workers

	Log of (unskilled workers)								
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)
Ln(tariff+1)	0.165***	0.238***	0.317***	0.208***	0.250***	0.376***	0.450***	0.273***	0.615***
	(0.039)	(0.040)	(0.046)	(0.046)	(0.049)	(0.063)	(0.134)	(0.058)	(0.121)
GDP (ln)		0.569**	0.627**				0.0119	0.560**	0.252
		(0.280)	(0.281)				(0.479)	(0.227)	(0.246)
Population (ln)		3.202***	3.177***				3.909***	3.167***	4.370***
		(0.595)	(0.636)				(0.786)	(0.490)	(0.611)
N. of PTAs		0.128	0.0982				0.101	0.135**	0.160**
		(0.092)	(0.095)				(0.077)	(0.061)	(0.063)
Export Intensity		1.367***	1.318**		1.384***	1.204**	1.112***	0.985***	0.799**
		(0.370)	(0.559)		(0.349)	(0.552)	(0.392)	(0.310)	(0.331)
Export Intensity*Ln(Tariff+1)		-0.726***	-0.691**		-0.745***	-0.625**	-0.563***	-0.496***	-0.403**
		(0.209)	(0.302)		(0.191)	(0.288)	(0.219)	(0.170)	(0.181)
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
Sector-Year	yes	yes	yes	yes	yes	yes	no	no	no
Country- Year	no	no	no	yes	yes	yes	no	no	no
Sample:	complete	complete	No Oil and metals	complete	complete	No Oil and metals	complete	complete	complete
Model	OLS	OLS	OLS	OLS	OLS	OLS	2SLS	2SLS	2SLS
IV used							Lag Tariff	Average Tariff	Initial Tariff
Observations	1379	1319	1100	1379	1319	1100	923	1319	1319
R-squared	0.933	0.934	0.941	0.942	0.941	0.948	0.931	0.932	0.925

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

Table 5: Trade liberalization and the wage of skilled/unskilled workers - wage premium

	Log of (skilled wage/unskilled wage)								
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)
Ln(tariff+1)	-0.233***	-0.265***	-0.335***	-0.320***	-0.345***	-0.450***	-0.505**	-0.208**	-0.681***
	(0.054)	(0.057)	(0.069)	(0.063)	(0.066)	(0.087)	(0.211)	(0.090)	(0.151)
GDP (ln)		-0.189	-0.132				0.360	-0.0972	0.285
		(0.357)	(0.367)				(0.581)	(0.300)	(0.325)
Population (ln)		-2.220***	-2.180**				-3.202***	-2.100***	-3.559***
		(0.801)	(0.868)				(1.103)	(0.691)	(0.766)
N. of PTAs		-0.237**	-0.210*				-0.218**	-0.244***	-0.276***
		(0.115)	(0.120)				(0.098)	(0.081)	(0.082)
Export Intensity		-0.074	0.006		-0.057	-0.009	-0.122	-0.116	-0.098
		(0.150)	(0.267)		(0.145)	(0.255)	(0.146)	(0.129)	(0.136)
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
Sector-Year	yes	yes	yes	yes	yes	yes	no	no	no
Country- Year	no	no	no	yes	yes	yes	no	no	no
Sample:	complete	complete	No Oil and metals	complete	complete	No Oil and metals	complete	complete	complete
Model	OLS	OLS	OLS	OLS	OLS	OLS	2SLS	2SLS	2SLS
IV used							Lag Tariff	Average Tariff	Initial Tariff
Observations	1309	1249	1046	1309	1249	1046	876	1249	1249
R-squared	0.946	0.943	0.944	0.953	0.950	0.952	0.940	0.941	0.937

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

Table 6: Trade liberalization and the wage of skilled workers

	Log of (skilled wage)								
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)
Ln(tariff+1)	-0.045***	-0.033*	-0.042**	-0.033	-0.031	-0.037	-0.076	-0.056**	-0.159***
	(0.017)	(0.018)	(0.020)	(0.021)	(0.022)	(0.026)	(0.065)	(0.026)	(0.051)
GDP (ln)		-0.323***	-0.316***				-0.219	-0.283***	-0.200*
		(0.119)	(0.116)				(0.198)	(0.098)	(0.104)
Population (ln)		0.082	0.060				-0.276	0.072	-0.258
		(0.256)	(0.268)				(0.360)	(0.210)	(0.263)
N. of PTAs		0.025	0.031				0.033	0.027	0.018
		(0.033)	(0.031)				(0.028)	(0.023)	(0.024)
Export Intensity		-0.041	0.109		-0.034	0.116	-0.044	-0.047	-0.044
		(0.048)	(0.080)		(0.046)	(0.074)	(0.044)	(0.039)	(0.039)
Unskilled wage (ln)	0.066***	0.065***	0.066***	0.075***	0.075***	0.076***	0.069***	0.062***	0.071***
	(0.012)	(0.012)	(0.010)	(0.013)	(0.013)	(0.012)	(0.014)	(0.011)	(0.013)
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
Sector-Year	yes	yes	yes	yes	yes	yes	no	no	no
Country- Year	no	no	no	yes	yes	yes	no	no	no
Sample:	complete	complete	No Oil and metals	complete	complete	No Oil and metals	complete	complete	complete
Model	OLS	OLS	OLS	OLS	OLS	OLS	2SLS	2SLS	2SLS
IV used							Lag Tariff	Average Tariff	Initial Tariff
Observations	1309	1249	1046	1309	1249	1046	876	1249	1249
R-squared	0.922	0.925	0.923	0.935	0.934	0.933	0.922	0.922	0.917

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

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Appendix

Table A1: Descriptive statistics

	Mean	Standard Deviation	Min	Max	N. Observations
Exported Value	50323	134382	0	129459	148299
Exported Quantity	26096	89177	0	945636	148299
Tariff	3.06	19.63	0	3000	148299
PTA	0.74	0.43	0	1	148299
Wage high skill	17.04	5.99	7.41	44.87	1249
Wage low skill	4.1	3.4	0.029	1881	1249
Skill Premia	20.48	81.1	0.44	1289	1249
Hours worked high skill	81.12	13.49	37.1	99.73	1249
Hours worked low skill	18.87	13.49	0.262	52.89	1249

Table A2: Trade liberalization and exported quantities - OLS

	Exported Quantities in Ln					Exported Values in Ln				
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)
Ln(Tariff+1)	-0.108***		-0.111***	-0.0133	-0.0628***	-0.154***		-0.156***	-0.00890	-0.120***
	(0.029)		(0.029)	(0.033)	(0.023)	(0.026)		(0.026)	(0.029)	(0.021)
PTA dummy		0.232***	0.237***	0.206***	0.144***		0.126***	0.132***	0.085***	0.045*
		(0.047)	(0.047)	(0.036)	(0.029)		(0.042)	(0.041)	(0.030)	(0.026)
Distance (Ln)	-1.889***	-1.901***	-1.901***	-1.970***	-1.891***	-1.627***	-1.635***	-1.634***	-1.688***	-1.620***
	(0.040)	(0.040)	(0.040)	(0.033)	(0.041)	(0.036)	(0.036)	(0.036)	(0.028)	(0.037)
Colony	0.610***	0.636***	0.635***	0.617***	0.573***	0.737***	0.752***	0.751***	0.742***	0.701***
	(0.065)	(0.064)	(0.065)	(0.056)	(0.066)	(0.057)	(0.057)	(0.057)	(0.049)	(0.059)
Common Language	0.605***	0.609***	0.608***	0.617***	0.614***	0.643***	0.646***	0.644***	0.653***	0.657***
	(0.033)	(0.033)	(0.033)	(0.026)	(0.034)	(0.030)	(0.030)	(0.030)	(0.022)	(0.030)
Contiguity	0.208***	0.204***	0.205***	0.260***	0.338***	0.173***	0.170***	0.172***	0.193***	0.293***
	(0.065)	(0.065)	(0.065)	(0.053)	(0.067)	(0.056)	(0.056)	(0.056)	(0.045)	(0.059)
ExpLiberalization					-0.212***					-0.089
					(0.074)					(0.062)
ImpLiberalization					-0.131***					-0.066
					(0.046)					(0.040)
Fixed Effects:										
Country	no	no	no	no	yes	no	no	no	no	yes
Year	no	no	no	no	yes	no	no	no	no	yes
Country-Year	yes	yes	yes	no	no	yes	yes	yes	no	no
Sector-Year	yes	yes	yes	no	yes	yes	yes	yes	no	yes
Country-Sector-Year	no	no	no	yes	no	no	no	no	yes	no
Observations	148,299	148,299	148,299	148,299	142,146	148,299	148,299	148,299	148,299	142,146
R-squared	0.739	0.739	0.740	0.866	0.733	0.749	0.749	0.749	0.878	0.742

Specifications in columns (5) and (10) include also per capita GDP, remoteness and price index for both exporting and importing countries
Standard errors in parentheses are clustered at country pair. *** $p < 0,01$; ** $p < 0,05$; *$p < 0,1$.

Table A3: Trade liberalization and exports (values and quantities) - 2SLS First Stage Regressions

	Ln(tariff+1)	PTA	Ln(tariff+1)	PTA
	(1)	(2)	(3)	(4)
IV Tariff (in ln)	0.869***		0.869***	-0.000
	(0.012)		(0.012)	(0.999)
N. of PTAs		0.020***	-0.001**	0.020***
by exporter		(0.001)	(0.000)	(0.000)
Observations	142301	148299	142301	142301
Shea Rsquared	0.536	0.041	0.537	0.041
Fstat excl.Instru.	4784	194	2392	270

Exporter, Importer-year,sector-year fixed effects included.
Cluster standard errors by importer-sector in columns 1.3 and 4; by exporter in 2
*** $p < 0,01; * * p < 0,05; * p < 0,1$.

Table A4: Trade liberalization and the employment of unskilled workers - First stage 2SLS

Dep Var	Ln(tariff +1)	Ln(tariff +1) x Exp. Intensity	Ln(tariff +1)	Ln(tariff +1) x Exp. Intensity	Ln(tariff +1)	Ln(tariff +1) x Exp. Intensity
	(1)	(2)	(3)	(4)	(5)	(6)
Ln(tariff +1)t-3	0.278***	-0.010***				
	(0.049)	(0.002)				
Average Tariff by Country			0.616***	-0.001		
			(0.039)	(0.001)		
Average Tariff by Sector			0.466***	-0.002		
			(0.127)	(0.002)		
Ln(tariff +1)t=0					0.419***	-0.010***
					(0.037)	(0.003)
Ln(tariff +1)t-3 x Exp Intensity	0.162**	0.307***				
	(0.067)	(0.016)				
Avg Tariff by Country x Exp Intensity			-0.206**	0.222***		
			(0.085)	(0.009)		
Avg Tariff by Sector x Exp Intensity			0.702***	0.193***		
			(0.165)	(0.020)		
Ln(tariff +1)t=0 x Exp Intensity					0.106*	0.308***
					(0.056)	(0.012)
Controls	yes	yes	yes	yes	yes	yes
Fixed Effects						
Country	yes	yes	yes	yes	yes	yes
Sector	yes	yes	yes	yes	yes	yes
Year	yes	yes	yes	yes	yes	yes
Observations	923	923	1319	1319	1319	1319
Shea R-squared	0.110	0.818	0.287	0.926	0.106	0.850
Fstat excl.instr	21.47	174.59	77.77	845.49	65.76	326.51
Sargan Test	-	-	0.883	0.883	-	-

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

Table A5: Trade liberalization and the wage gap - First stage 2SLS

	Ln(tariff +1)		
	(1)	(2)	(3)
Ln(tariff +1)t-3	0.276***		
	(0.053)		
Average Tariff by Country		0.649***	
		(0.044)	
Average Tariff by Sector		0.495***	
		(0.124)	
Ln(tariff +1)t=0			0.420***
			(0.037)
Controls	yes	yes	yes
Fixed Effects			
Country	yes	yes	yes
Sector	yes	yes	yes
Year	yes	yes	yes
Observations	876	1249	1249
Shea R-squared	0.096	0.265	0.105
Fstat excl.instr	27.11	115.75	125
Sargan Test	-	0.720	-

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

Table A6: Trade liberalization and the wage of high skill workers - First stage 2SLS

	Ln(tariff +1)		
	(1)	(2)	(3)
Ln(tariff +1)t-3	0.267***		
	(0.052)		
Average Tariff by Country		0.643***	
		(0.043)	
Average Tariff by Sector		0.487***	
		(0.126)	
Ln(tariff +1)t=0			0.406***
			(0.037)
Controls	yes	yes	yes
Fixed Effects			
Country	yes	yes	yes
Sector	yes	yes	yes
Year	yes	yes	yes
Observations	876	1249	1249
Shea R-squared	0.091	0.264	0.098
Fstat excl.instr	26.06	114.31	114.98
Sargan Test	-	0.845	-

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

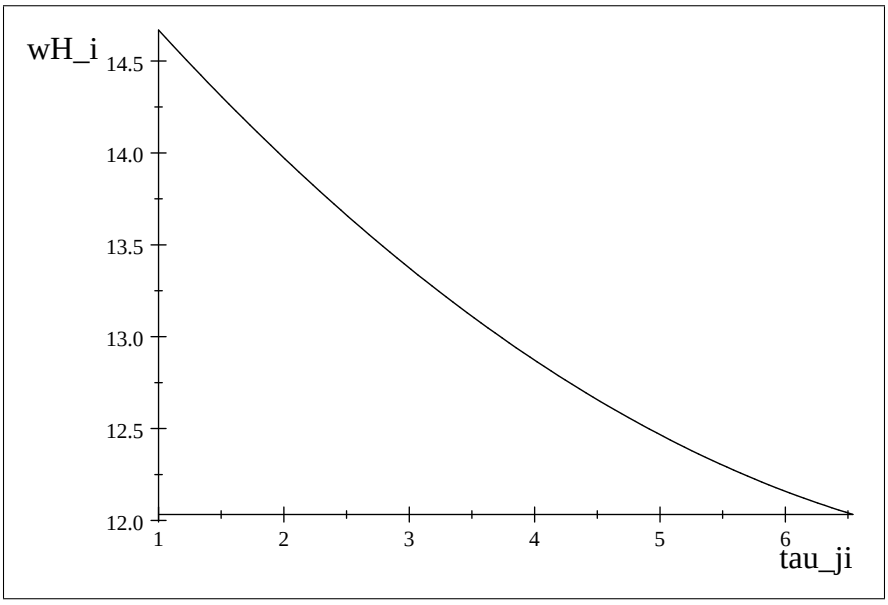

Figure 1. The wage of skilled workers in region i, w_i^H. The parmeters of the simulation are the following: $\tau_{jz} = 4; \alpha = 10; h = 1; H_i = 10; H_j = 20; H_z = 30; \beta = 2; c = 0.1; \gamma = 2; \tau_{zi} = 3; L_z = 10; L_i = 10; L_j = 10; K = 10.$