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Trade, Technology Adoption and Wage Inequalities: Theory and Evidence

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Abstract

This paper develops a model of trade that features heterogeneous firms, technology choice and different types of skilled labor in a general equilibrium framework. Its main contribution is to explain the impact of trade integration on technology adoption and wage inequalities. It also provides empirical evidence to support the model's main assumption and predictions using plant-level panel data from Chile's manufacturing sector (1990-1999). The theoretical framework offers a possible explanation of the puzzling increase in skill premium in the developing countries. The key mechanism is found in the effects of trade policy on the number of new firms upgrading technology and on the skill-intensity of labor. Trade liberalization pushes up export revenues, raising the probability that the most productive exporters will upgrade their technology. These firms then increase their relative demand for skilled labor, thereby raising inequalities.

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1 Introduction

This paper considers a number of observations described in the empirical literature on international trade, namely: (1) globalization; (2) firms in the same industry are heterogeneous; (3) the increase in wage inequalities in unskilled labor-intensive countries; and (4) foreign technology transfers to developing countries.

Trade liberalization took place in most developing countries in the 1980s and the early 1990s. This process encompassed the reduction of unilateral import tariffs and non-tariff barriers and the development of bilateral and multilateral trade agreements among countries in the same region.

Several empirical studies confirm the existence of heterogeneous characteristics among firms in the same industry. They demonstrate that exporters are more productive, larger, more intensive in skilled labor and more capital-intensive than firms selling only to the domestic market. Roberts and Tybout (1997), Clerides, Lach and Tybout (1998), Bernard and Jensen (1995, 1999, 2004), Bernard and Wagner (1998), Sullivan (1997), Aw, Chung and Roberts (2000), and Kraay (2002) all find that exporters perform better than non-exporters.

There is also empirical evidence of growing wage inequalities between skilled and unskilled labor due to a higher proportion of skilled workers within industries following trade reforms in unskilled labor-intensive developing countries. A reduction in import tariffs brings down the relative price of imported intermediate and capital goods, raising the relative demand for skilled labor [1]. The second explanation focuses on how foreign competition impacts on final goods. Trade liberalization increases the number of foreign competitors and encourages domestic firms to adopt high technology or conduct skill-biased technological change [2].

This paper's main contribution to the existing literature is to investigate trade-induced technological change in a general equilibrium framework of heterogeneous firms. A fixed technology adoption cost and both skilled and unskilled labor are introduced into a model of monopolistic competition and heterogeneous firms to explain the effects of trade on technology choice and wage inequalities.

The mechanisms by which trade policy affects the relative demand for skilled labor and skill premium have been largely studied. Two types of arguments can be identified, depending on whether they focus mainly on the effects of international trade or on technological change.

Bernard, Redding and Schott (BRS) (2006) developed a two-sector model using the Hecksher-Ohlin-Samuelson framework and introducing heterogeneous firms in each sector. The main difference with our framework is that we focus on the relationship between trade, technology choice and wage inequalities. The key mechanism explaining the rise in wage inequalities in our model is based on the existence of a fixed skill-biased technology cost. In this model, the level of skill intensity required by firms is determined by their endogenous decision to upgrade technology, while the level of skill intensity in the BRS model is

[1] Gasparini and Acosta (2002) and Bustos (2005) on Argentina, Sanchez-Paramo and Schady (2003) on Argentina, Chile, Colombia and Mexico, Verhoogen (2006) on Mexico and Muendler et al. (2003) on Brazil all find evidence of a positive correlation between skill premium and foreign technology acquisition in all sectors following trade liberalization.

[2] Behrman, Birdsall and Szekely (2000) on 18 Latin American countries, Thoenig and Verdier (2003) on France, Attanasio, Goldberg and Pavnick (2004) on Colombia, Muendler et al. (2003) on Brazil all find evidence supporting this argument.

exogenously determined [3].

The second type of argument is based on skill-biased technological change (SBTC). These models have been developed mainly by Acemoglu (2003) and Thoenig and Verdier (2003). International trade prompts innovation and SBTC, thereby raising the relative demand for skilled labor and hence the skill premium. The model presented in this paper focuses on a different and complementary channel based on technology adoption to explain the relation between trade liberalization and wage inequalities.

Some theoretical studies link both arguments: trade-induced skill-biased technological change. Ekholm and Midelfart (2005) explore the impact of trade liberalization on relative returns to skilled and unskilled labor. Trade openness increases the market access of firms, creating incentives to upgrade skill-intensive technology and raising the skill premium. To investigate the effects of trade on technology choice, our model introduces firms that are heterogeneous in terms of their productivity gains.

The model developed in this paper is also closely related to Yeaple (2005), who develops a trade model of homogeneous firms and heterogeneous skills. In Yeaple's model, firm heterogeneity is an endogenous result of the distribution of skilled workers and technology choice. Trade reduces the relative fixed costs of high technology and thus increases the share of skilled labor and the skill premium. Unlike Yeaple (2005), the firms in our model are heterogeneous even before they start producing and each firm employs both skilled and unskilled workers. Trade liberalization encourages technology adoption in unskilled-intensive sectors, thereby raising their skilled labor demand. Another important departure from Yeaple's model is that we take into account the effects of the skill premium on firm's decisions.

Bustos (2005) expands on Melitz (2003) and Yeaple (2005) to explain the skill upgrading prompted by technology adoption that follows the implementation of trade reforms in developing countries. Using Argentinean firm level data, she finds empirical evidence supporting the argument of trade-induced skill-biased technological change. In the theoretical framework, Bustos considers neither the firm's entry-exit process nor the reallocation of resources among firms or the impact of relative wages on price indexes and other aggregate variables. Conversely, I develop a general equilibrium model that considers the impact of the skill premium on aggregate variables and on the selection process into the domestic and foreign markets.

In order to characterize the differences between firms in the same industry, we introduce firm heterogeneity in keeping with Melitz (2003). However, his model is based on the assumption of homogeneous labor. The introduction of different types of skilled labor and skill-intensity differences between firms enables us to explain the effects of trade integration on the skill premium. We introduce two sources of cross-plant productivity variation. The first is an exogenous Hicks-neutral productivity factor, which is drawn from a continuous distribution. The second is an endogenous skilled-labor-augmenting productivity factor, which is binary. The high-productivity value of this factor is available to firms that are willing to pay a fixed technology adoption cost.

Trade liberalization changes the scope for profits in the domestic and foreign markets. The reduction

[3] Some studies focus on outsourcing as the main mechanism explaining the rise in skill premium in industrialized and developing countries. See Feenstra and Hanson (1999, 2000).

of variable trade costs makes low productivity firms worse off and high productivity firms better off, as shown by Melitz's model ("selection effect"). Following the implementation of trade reforms, the increase in export revenues raises the probability that the most productive low technology exporters will upgrade their technology. These firms increase their relative demand for skilled labor, thereby raising the skill premium. The latter effect is beneficial to low-technology firms compared with high-technology firms. Since the increase in the skill premium is a second order effect, the "net effect" of reductions in trade frictions on both the extensive margin of trade and the extensive margin of technology is positive.

Lastly, we provide empirical evidence in support of the theoretical model's main assumption and predictions based on plant level panel data from Chile's manufacturing sector for the period 1990-1999. We first estimate a translog cost function to test the assumption of skill-biased technology. We then test the predictions: (1) whether trade cost reduction encourages exporters to upgrade their technology and (2) whether these exporters have a higher relative demand for skilled labor following trade liberalization. This is done using specific data on export barriers at industry level.

The rest of the paper is structured as follows. Section 2 shows how the model is set up. Section 3 presents the main theoretical findings. Section 4 presents the empirical estimations. Section 5 contains the conclusion.

2 Setup of the model

2.1 Closed economy equilibrium

2.2 Households Consumption

The representative household allocates consumption from among the range of domestic goods (j) produced using low technology (Ω_l) and those produced using more advanced and skill-biased technology (Ω_h). The standard CES utility function (C) represents the consumer preferences. The elasticity of substitution between low and high technology goods is $\phi > 1$: $C = \left(\int_{j \in \Omega_l} C_{lj}^{\frac{\phi-1}{\phi}} dj + \int_{j \in \Omega_h} C_{hj}^{\frac{\phi-1}{\phi}} dj \right)^{\frac{\phi}{\phi-1}}$

The optimal relative demand functions are: $C_i = \left(\frac{P}{p_i} \right)^{\phi} C \qquad i = \{l, h\}$ (1.A)

2.3 Production

There is a continuum of firms, each producing a different range of goods, in monopolistic competition. Production requires two different types of labor: unskilled (l_i) and skilled (h_i) inelastically supplied. Heterogeneous firms with different productivity levels (φ) are introduced, in keeping with Melitz (2003). We adopt a CES production technology that combines skilled and unskilled labor to produce output.

$$Y_i = \varphi \left((a_h h_i)^{\alpha} + (l_i)^{\alpha} \right)^{\frac{1}{\alpha}} \qquad i = \{l, h\} \qquad a_h = \{1, s\} \qquad s > 1 \qquad (2.A)$$

The subscript "l" represents firms producing with low technology and "h" those using high technology. The coefficient "a_h " represents the efficiency of high technology, corresponding to skilled labor. The elasticity of substitution between the two types of labor is $\sigma = \frac{1}{1-\alpha}$. We assume that skilled and unskilled labor are imperfect substitutes, hence $0 < \alpha < 1$ and $1 \leq \sigma \leq \infty$.

There are three types of fixed costs in a closed economy: (1) a fixed sunk entry cost (f_E), that firms have to pay to enter the market (e.g. costs to develop a blueprint); (2) a fixed per-period cost (f) that all firms incur, such as that associated with investment in local distribution; and (3) a fixed per-period technology adoption cost (f_t), which represents investment in new and more advanced skill-biased technology. To make the model tractable, all fixed costs are measured in units of imported capital and their price is normalized to one. Two groups of domestic firms can be identified in a closed economy equilibrium: (1) low productivity firms without enough profits to assume the fixed technology costs (N_l); and (2) the most productive firms, which have acquired new technology (N_h). The first-order condition of monopolistic firms is such that prices reflect a constant mark-up over marginal cost. In this model, marginal costs can be divided into an intrinsic productivity term (φ) and the unit cost of production (c_l or c_h), which reflects the ratio of skilled (w_h) to unskilled (w_l) wages paid by the firm.

Low technology firms (N_l)	**High technology firms (N_h)**
(3.A) $p_l = \frac{\phi}{\phi-1}\frac{c_l}{\varphi_i}$	$p_h = \frac{\phi}{\phi-1}\frac{c_h}{\varphi_i}$
(4.A) $c_l = \left((w_l)^{\frac{\alpha}{\alpha-1}} + (w_h)^{\frac{\alpha}{\alpha-1}}\right)^{\frac{\alpha-1}{\alpha}}$	$c_h = \left((w_l)^{\frac{\alpha}{\alpha-1}} + \left(\frac{w_h}{a_h}\right)^{\frac{\alpha}{\alpha-1}}\right)^{\frac{\alpha-1}{\alpha}}$
(5.A) $r_l = \left(\frac{P}{p_l}\right)^{\phi-1} R$	$r_h = \left(\frac{P}{p_h}\right)^{\phi-1} R$
$r_l = r_h \left(\frac{c_h}{c_l}\right)^{\phi-1}$	$r_h = r_l \left(\frac{c_h}{c_l}\right)^{1-\phi}$
(6.A) $\pi_l = p_l Y_l - w_l l_l - w_h h_l - f$	$\pi_h = p_h Y_h - w_l l_h - w_h h_h - f - \delta f_t$
$\pi_l = \frac{r_l}{\phi} - f$	
Goods Market Equilibrium	(7.A) $Y_i = C_i$ for $i = \{l, h\}$

High-technology firms have to pay a fixed technology adoption cost (f_t), but have a lower marginal cost since skill efficiency "$a_h > 1$" reduces the unit cost (c_h). Note that "a_h" is not heterogeneous, since all firms that upgrade their technology reduce their unit cost by the same proportion. Even if two firms have the same productivity level, the revenues of the firm using the more advanced technology are higher than those of the low-technology firm ($c_l > c_h \Rightarrow r_l < r_h$). Hence, firms that decide to upgrade technology increase their revenues by $\left(\frac{c_h}{c_l}\right)^{1-\phi}$. Otherwise, the firm employs low technology, where $a_h = 1$. The introduction of heterogeneous firms in terms of productivity levels determines the endogenous technological status of the firms. Only the most productive firms can switch to high technology and become even more efficient. The term $\left(\frac{c_h}{c_l}\right)$ represents the relative unit cost of skilled labor and is determined by both the skill premium $\omega(\frac{w_h}{w_l})$ and skill efficiency "a_h". This relative skilled labor unit cost is an increasing function of the skill premium $\frac{\partial \frac{c_h}{c_l}}{\partial \omega} > 0$ since $0 < \alpha < 1$ (See Appendix 1).

$$\left(\frac{c_h}{c_l}\right) = \left(\frac{(\omega)^{\frac{\alpha}{1-\alpha}}+1}{(\omega)^{\frac{\alpha}{1-\alpha}}+(a_h)^{\frac{\alpha}{1-\alpha}}}\right)^{\frac{1-\alpha}{\alpha}} \qquad (8.A)$$

2.4 Firm's decisions

2.4.1 The decision to exit or stay and produce

Firms have to pay a sunk entry cost to enter the market before they know what their productivity level will be. Entrants then derive their productivity "φ" from common distribution density $g(\varphi)$, with support $[0, \infty]$ and cumulative distribution $G(\alpha)$[4]. Since there is a fixed production cost (f), only those firms with enough profits to pay this cost can produce. The profits of the marginal firm that decides to stay and produce are equal to zero:$\pi_l\left(\varphi_l^*\right) = 0$. The value "$\varphi_l^*$ " is the productivity cutoff to produce.

$$\frac{r_l(\varphi_l^*)}{\phi} = f \qquad \Rightarrow \qquad \varphi_l^{*\phi-1} = f \; c_l^{\phi-1} \frac{\phi}{\Psi} \qquad (9.A) \qquad \text{Where } \; \Psi = P^{\phi-1} R \left(\frac{\phi}{\phi-1}\right)^{1-\phi}$$

2.4.2 The decision to adopt high technology

If a firm decides to stay in the market once it has received its productivity draw, it may also decide to upgrade its technology to reduce its unit costs on the basis of its profitability. Only a subset of the most productive firms will switch to high technology since the fixed technology cost is higher than the fixed production cost. The firms that do will be those whose increase in domestic revenues due to their adoption of high technology enables them to pay the fixed technology costs. The condition to acquire the new and more advanced technology is given by: $\pi_h(\varphi_h^*) = \pi_l(\varphi_h^*)$

$$\frac{[r_h(\varphi_h^*) - r_l(\varphi_h^*)]}{\phi} = \delta f_t \qquad \Rightarrow \varphi_h^{*\phi-1} = \frac{\delta f_t}{\left[c_h^{1-\phi} - c_l^{1-\phi}\right]} \frac{\phi}{\Psi} \qquad (10.A)$$

The productivity cutoff for technology upgrading is represented by "φ_h^*". This value is the minimum productivity level for the marginal firm able to adopt high technology. By combining equation (9.A) with (10.A), we obtain φ_h^* as an implicit function of φ_l^*.

$$\left(\frac{\varphi_h^*}{\varphi_l^*}\right)^{\phi-1} \quad \Rightarrow \quad \varphi_h^* = \varphi_l^* \left(\frac{\delta f_t}{f}\right)^{\frac{1}{\phi-1}} \left[\left(\frac{c_h}{c_l}\right)^{1-\phi} - 1\right]^{\frac{1}{1-\phi}} \qquad (11.A)$$

*** To ensure that $\varphi_h^* > \varphi_l^*$, we have to assume that the amortized value of the fixed technology cost is much higher than the fixed production cost. The partitioning condition that sustains the closed economy equilibrium is written: $\frac{\delta f_t}{\left[\left(\frac{c_h}{c_l}\right)^{1-\phi} - 1\right]} > f \qquad (11'.A)$.

2.5 Aggregation

The distribution of the productivity levels of low- and high-technology firms is represented by $\mu_l(\varphi)$ and $\mu_h(\varphi)$, respectively. Therefore, $\mu_l(\varphi)$ is the conditional distribution of $g(\varphi)$ on $[\varphi_l^*, \varphi_h^*]$ while $\mu_h(\varphi)$ is the conditional distribution of $g(\varphi)$ on $[\varphi_h^*, \infty)$.

$$\mu_l(\varphi) = \frac{g(\varphi)}{G(\varphi_h^*) - G(\varphi_l^*)} \;\; \text{if } \varphi_l^* < \varphi_i < \varphi_h^* \;\; (12.A) \;\; ; \mu_h(\varphi) = \frac{g(\varphi)}{1 - G(\varphi_h^*)} \;\; \text{if } \varphi_i > \varphi_h^* \;\; (13.A)$$

[4]These functions are defined in the following section.

Where $[1-G(\varphi_l^*)]$ and $[1-G(\varphi_h^*)]$ represent the ex-ante probability of successful entry and the ex-ante probability of having a productivity draw higher thanφ_h^*. These distributions define the weighted averages of the firms' productivity levels as functions of the cutoffs.

$$\widetilde{\varphi_l}^{\phi-1} \equiv \frac{1}{G(\varphi_h^*)-G(\varphi_l^*)} \int_{\varphi_l^*}^{\varphi_h^*} (\varphi)^{\phi-1} g(\varphi)d\varphi \quad (14.A); \quad \widetilde{\varphi_h}^{\phi-1} \equiv \frac{1}{1-G(\varphi_h^*)} \int_{\varphi_h^*}^{\infty} (\varphi)^{\phi-1} g(\varphi)d\varphi \quad (15.A)$$

$\widetilde{\varphi_h}$ represents the ex-ante weighted average productivity level of high-technology firms before they decide to adopt the technology. The ex-post productivity average of high-technology firms has to take into account the increase in the firms' efficiency due to the acquisition of the more advanced technology that allows them to reduce their unit costs and raise their market shares by this term $\left(\frac{c_h}{c_l}\right)^{1-\phi}$ since $r_h(\widetilde{\varphi_h}) = r_l(\widetilde{\varphi_h})\left(\frac{c_h}{c_l}\right)^{1-\phi}$. Therefore, the weighted average productivity index of the economy $(\widetilde{\varphi_T})$ represents the market shares of all the firms. The low- and high-technology average productivity levels and the aggregate productivity index define all the aggregate variables (see Appendix 1).

$$\widetilde{\varphi_T}^{\phi-1} = \frac{1}{N}\left[N_l\left(\widetilde{\varphi_l}\right)^{\phi-1} + N_h\left(\frac{c_h}{c_l}\right)^{1-\phi}\left(\widetilde{\varphi_h}\right)^{\phi-1}\right] \quad (16.A)$$

2.6 Labor Market Equilibrium and the Skill Premium

Both skilled and unskilled labor are assumed to be perfectly mobile across firms in a country. Although firms have different labor demands depending on their productivity level, all firms pay the same skilled and unskilled wage. This means that there is a unique skill premium in a country, which is determined by the aggregate skilled and unskilled labor demands.

Firms' skilled and unskilled labor demands are determined by profit maximization. By plugging equation 2.A (production function) into equation 6.A (profit function), the profit maximization process yields the following relationship between skilled labor, unskilled labor and the skill premium:

$$\frac{h_i}{l_i} = \omega^{\frac{1}{\alpha-1}}\left(a_h\right)^{\frac{\alpha}{1-\alpha}} \qquad \text{for } i=\{l,h\} \qquad a_h>1 \quad if i=h \qquad (17.A)$$

Firms producing with more advanced skill-biased technology will have a higher relative skilled labor demand than firms using low technology. In monopolistic competition, firms anticipate their final demand. Plugging equation 17.A into 2.A and then into the goods market equilibrium equation (7.A) yields the firms' skilled and unskilled labor demands[5].

$$l_i = \frac{C_i}{\varphi}c_i^{\frac{1}{1-\alpha}}\left(w_l\right)^{\frac{1}{\alpha-1}} \qquad (18.A) \qquad h_i = \frac{C_i}{\varphi}c_i^{\frac{1}{1-\alpha}}\left(w_h\right)^{\frac{1}{\alpha-1}}\left(a_h\right)^{\frac{\alpha}{1-\alpha}} \qquad (19.A)$$

Where C_i is the demand for good "i" produced with low (l) or high (h) technology, and c_i is per unit cost. The overall national demand for unskilled and skilled labor is determined by aggregating the firms' individual demands (see Appendix 1).

$$L^d = \int_{\varphi_l^*}^{\varphi_h^*} N_l l_l(\varphi)\mu_l(\varphi)d\varphi + \int_{\varphi_h^*}^{\infty} N_h l_h(\varphi)\mu_h(\varphi)d\varphi \qquad (20.A)$$

[5]By using the price rule given by equation 3.A, inserting 7.A (goods market equilibrium) into 6.A. (profit function), and plugging equation 18.A (labor demands) into 17.A and then into 6.A, we find that :$\pi_l = \frac{r_l}{\phi} - f = p_l Y_l - w_l l_l - w_h h_l - f$

$$H^d = \int_{\varphi_l^*}^{\varphi_h^*} N_l h_l(\varphi)\,\mu_l(\varphi)d\varphi + \int_{\varphi_h^*}^{\infty} N_h h_h(\varphi)\,\mu_h(\varphi)d\varphi \qquad (21.A)$$

The skill premium (ω) is determined by the equality between aggregate relative skilled labor demand and supply. $\frac{H^s}{L^s} = \frac{H^d}{L^d} \qquad \Rightarrow \omega = g(\frac{H^s}{L^s}, a_h, N_l, N_h, \frac{\widetilde{\varphi_h}}{\widetilde{\varphi_l}})$

$$\frac{H^s}{L^s} = \omega^{\frac{1}{\alpha-1}} \left(\frac{1+(a_h)^{\frac{\alpha}{1-\alpha}}\left(\frac{N_h}{N_l}\right)\left(\frac{\widetilde{\varphi_h}}{\widetilde{\varphi_l}}\right)^{\phi-1} A}{1+\left(\frac{N_h}{N_l}\right)\left(\frac{\widetilde{\varphi_h}}{\widetilde{\varphi_l}}\right)^{\phi-1} A} \right) \qquad (22.A) \qquad \text{where } A = \left(\frac{c_h}{c_l}\right)^{-\phi} \left(\frac{(\omega)^{\frac{\alpha}{\alpha-1}}+1}{\left(\frac{\omega}{a_h}\right)^{\frac{\alpha}{\alpha-1}}+1} \right)^{\frac{1}{\alpha}}$$

2.7 Closed Economy Equilibrium Conditions

Unlike Melitz's model, the equilibrium productivity cutoff level(φ_l^*) depends on the skill premium, which is determined by equation 22.A. In this model, therefore, the equilibrium value of φ_l^* is determined by three conditions: the free entry condition (FE), the zero cutoff profits condition (ZCP) and the labor market clearing condition (LMC). The value of φ_l^* at equilibrium will then pin down the rest of the model's variables.

The Free Entry Condition (FE): before entering the market and knowing their productivity level, firms calculate the present value of average profit flows to decide whether to enter the domestic market. All firms except the marginal firms earn positive profits. Hence, average profit level $\widetilde{\pi}$ is positive. As in Melitz (2003), $\widetilde{v}$ is the present value of the average profit flows: $\widetilde{v} = \left[\sum_{t=0}^{\infty} (1-\delta)^t \,\widetilde{\pi}\right]$ and v^E is the net value of entry given by[6]: $v^E = (1 - G(\varphi_l^*))\,\widetilde{v} - f_E = \frac{1-G(\varphi_l^*)}{\delta}\widetilde{\pi} - f_E$. FE states that the value of entry is equal to zero.

$$\textbf{FE:} \qquad v^E = 0 \qquad \Rightarrow \widetilde{\pi} = \frac{\delta f_E}{\left(1-G(\varphi_l^*)\right)} \qquad (23.A)$$

The Zero Cutoff Profit Condition (ZCP): also determines a relation between average profits and the productivity level of the marginal firm.

$$\textbf{ZCP:} \qquad \widetilde{\pi} = \rho_l \pi_l(\widetilde{\varphi_l}) + \rho_h \pi_h(\widetilde{\varphi_h}) \qquad (24.A)$$

Assumption 1: *Productivity draws are distributed according to a Pareto distribution* $g(\varphi) = \frac{k(\varphi_{\min})^k}{(\varphi)^{k+1}}$ *with a lower bound* $\varphi_{\min}$ *and a shape parameter* k *(see Appendix 1).*

Proposition 1: *Under Assumption 1 and the partitioning condition (eq. 11'.A), there exists a unique equilibrium cutoff* (φ_l^*) *determined by ZCP, FE and LMC.*

Proof. *See Appendix 1* •

$$\textbf{ZCP=FE} \qquad \varphi_l^* = f(a_h, \omega, f_E, f, f_t, \delta)$$

$$\textbf{LMC} \qquad \frac{H^s}{L^s} = \frac{H^d}{L^d} \qquad \Rightarrow \omega = g(\frac{H^s}{L^s}, a_h, f, f_t, \delta)$$

[6].The factor of discount is modeled following Melitz with a Poisson death shock probability.

Proposition 2: *Under Assumption 1 and the partitioning condition (eq. 11'.A), φ_l^* is a decreasing function of the skill premium but the aggregate relative skilled labor demand does not depend on φ_l^* and therefore the skill premium is independent of this cutoff.*[7] $\frac{\partial \varphi_l^*}{\partial \frac{c_h}{c_l}} < 0$.

Proof. *See Appendix 1* •

This implies that an increase in the relative skilled labor unit cost ($\frac{c_h}{c_l}$), due to an increase in the skill premium ($\frac{\partial \frac{c_h}{c_l}}{\partial \omega} > 0$), reduces the productivity cutoff. Hence, an increase in the skill premium benefits the least productive unskilled-intensive firms. This cutoff (φ_l^*) then determines the technological cutoff level (φ_h^*) using equation (11.A).

Proposition 3: *Under Assumption 1 and the partitioning condition (eq. 11'.A), the technological cutoff (φ_h^*) is an increasing function of the relative skilled per unit cost and of the skill premium. An increase in the relative skill per unit cost reduces the number of firms producing with high technology skilled biased:*$\frac{\partial \varphi_h^*}{\partial \frac{c_h}{c_l}} > 0$.

Proof. *See Appendix 1* •

The Capital Market Condition: imported capital is required to pay fixed entry costs and production and technology adoption costs. It is supplied inelastically by the rest of the world under the assumption that capital markets operate independently from labor markets[8]. Its price is normalized to one. The capital market clearing condition is[9]: $K = N_l f + N_h (f + \delta f_t) + N_E \delta f_E$ (25.A)

The Global Accounting condition:establishes that the sum of unskilled and skilled revenues and the capital used to paid fixed costs is equal to the aggregate revenue of the economy (R).

$$w_h H + w_l L + K = R \qquad (26.A)$$

$R = N\widetilde{r}$ and $\widetilde{\pi} = \frac{\widetilde{r}}{\phi} - f - \delta f_t \rho_h$. The total number of firms is obtained by using the average profit to obtain average revenue and plugging it into this condition (eq. 26.A).

$$N = \frac{w_h H + w_l L + K}{(\widetilde{\pi} + f + \delta f_t \rho_h)\phi} \qquad (27.A)$$

2.8 Open economy

Countries are symmetric in the open economy equilibrium. Aggregate variables (prices, consumption and revenues) are equivalent in both countries. So there are no differences in the notation of variables for home and foreign countries. In an open economy equilibrium, there are two different cases depending

[7] In the general case, the aggregate relative skilled labor demand depends on the average productivities and thereby on the cutoffs. There is a unique solution (ω,φ_l^*) determined by the intersection between Free Entry-ZCP condition and the Labor Market Condition. In this case the impact of trade variable costs is ambiguous. Therefore I assume the Pareto distribution to get an analytical solution of the equilibrium cutoff.

[8] If we assume that fixed costs are paid with skilled and unskilled labor, this will complicate the calculation and the skilled premium will be a function of the production productivity cutoff.

[9] The number of firms producing with low technology ($N_l = \rho_l N$), those producing with high technology ($N_h = \rho_h N$) and the number of new entrants ($N_E = \frac{\delta N}{1-G(\varphi_l^*)}$) are determined by the total number of firms and the probabilities which depend on productivity cutoff levels.

on the relation between the fixed technology cost (f_t), fixed (f_x) and variable trade costs (τ) and the relative skilled labor unit cost ($\frac{c_h}{c_l}$). The first case represents an economy where fixed technology costs are substantially higher than fixed and variable trade costs. Under these conditions, there are three groups of firms: (1) the least productive firms selling only on the domestic market and producing with low technology (N_{dl}); (2) exporters producing with low technology (N_{xl}); and (3) the most productive firms capable of exporting and upgrading their technology (N_{xh}). In the second case, fixed and variable trade costs are higher than the fixed technology cost. All exporters produce with high technology and there are two different types of domestic firms. Since the Chile data patterns fit the first case better (see Section 4), we only derive the equilibrium for this case[10].

2.9 Set-up of the open economy equilibrium

2.10 Households Consumption

Goods produced by domestic firms can be traded or not and produced using low or high technology depending on the firm's profitability. The representative household allocates consumption from among a set of domestic goods produced with low technology (Ω_{dl}) and two different sets of foreign imported varieties produced with low (Ω_{xl}) and high technology (Ω_{xh}). Consumers preferences are represented by the standard C.E.S. utility function: $C = \left(\int_{j\in\Omega_{dl}} C_{dl}^{\frac{\phi-1}{\phi}} dj + \int_{j\in\Omega_{xl}} C_{xl}^{\frac{\phi-1}{\phi}} dj + \int_{j\in\Omega_{xh}} C_{xh}^{\frac{\phi-1}{\phi}} dj \right)^{\frac{\phi}{\phi-1}}$

The optimal relative demand functions are: $C_i = \left(\frac{P}{p_i}\right)^{\phi} C \qquad \text{for } i = \{dl, xl, xh\} \qquad (1.B)$

2.11 Production

Similar to the closed economy equilibrium, the production function using skilled and unskilled labor is represented by a CES function given by: $Y_i = \varphi\left((a_h h_i)^{\alpha} + (l_i)^{\alpha}\right)^{\frac{1}{\alpha}} \qquad \text{for } i = \{dl, xl, xh\} \qquad (2.B)$

Only the most productive exporters will be able to switch to high technology. Since high technology is skilled biased, the firms that acquire this technology will have greater skilled labor efficiency ($a_h > 1$) and a lower marginal cost ($c_h < c_l$). More productive firms have lower unit costs and are thereby able to set lower prices and have higher revenues as well as greater profits.

1.Non exporters - Low Technology (N_{dl})

(3.B) $p_{dl} = \frac{\phi}{\phi-1}\frac{c_l}{\varphi_i}$ (5.B) $r_{dl} = \left(\frac{P}{p_{dl}}\right)^{\phi-1} R$

(4.B) $c_l = \left((w_l)^{\frac{\alpha}{\alpha-1}} + (w_h)^{\frac{\alpha}{\alpha-1}}\right)^{\frac{\alpha-1}{\alpha}}$ (6.B) $\pi_{dl} = p_{dl}Y_{dl} - w_l l_{dl} - w_h h_{dl} - f = \frac{r_{dl}}{\phi} - f$

2.Exporters - Low Technology (N_{xl})

$p_{xl} = p_{dl}(1+\tau)$

$r_{xl} = \left(\frac{P}{p_{dl}(1+\tau)}\right)^{\phi-1} R$

$\pi_{dl} + \pi_{xl} = \frac{r_{dl}\left[1+(1+\tau)^{1-\phi}\right]}{\phi} - f - \delta f_x$

3. Exporters - High Technology (N_{xh})

$r_{xh} = \left(\frac{P}{p_{dh}(1+\tau)}\right)^{\phi-1} R$

$r_{dh} + r_{xh} = r_{dh}\left[1 + (1+\tau)^{1-\phi}\right]$

$\pi_{dh} + \pi_{xh} = \frac{r_{dh}\left[1+(1+\tau)^{1-\phi}\right]}{\phi} - f - \delta f_x - \delta f_t$

Goods Market Equilibrium (7.B) $C_i = Y_i$ for $i = \{dl, dh\}$; $C_i = \frac{Y_i}{(1+\tau)}$ for $i = \{xl, xh\}$

[10]The derivation of the second open economy equilibrium is available in the author's PhD dissertation.

Given that unit costs (c_l, c_h) are independent of productivity levels, note that equation (4.B) in the open economy scenario is identical to (4.A). The relative unit costs remain unchanged (equation 8.B = 8.A).

2.12 Firm's decisions

2.12.1 Production and Export decision

Both the decision to enter the market and to produce remain unchanged relatively to the closed economy equilibrium. The marginal firm that decides to stay is the one whose profits are equal to zero:

$$\pi_{dl}\left(\varphi_{dl}^*\right) = 0 \;\Rightarrow\; \frac{r_{dl}(\varphi_{dl}^*)}{\phi} = f \;\;\Rightarrow \varphi_{dl}^{*\phi-1} = f \;\; c_l^{\phi-1}\frac{\phi}{\Psi} \qquad (9.B)$$

Similar to Melitz (2003), the tradability condition implies that only firms with operating profits that offset the amortized fixed export cost per period (δf_x)) will be able to export. The zero cutoff profits condition to enter the export market is given by:

$$\pi_{xl}\left(\varphi_{xl}^*\right) = 0 \qquad \Rightarrow \frac{r_{xl}}{\phi} = \delta f_x \qquad \Rightarrow \varphi_{xl}^{*\phi-1} = \delta f_x \left(1+\tau\right)^{\phi-1} c_l^{\phi-1}\frac{\phi}{\Psi} \qquad (10.1.B)$$

The export productivity cutoff is represented by "φ_{xl}^*". This value corresponds to the productivity level of the marginal firm able to enter the foreign market. Combining (9.B) and (10.1.B) leads to the definition of φ_{xl}^* as an implicit function of φ_{dl}^* :

$$\frac{r_{xl}(\varphi_{xl}^*)}{r_{dl}\left(\varphi_{dl}^*\right)} = \frac{\delta f_x \phi}{f\phi} \qquad \Rightarrow \qquad \varphi_{xl}^* = \varphi_{dl}^*\left(\frac{\delta f_x}{f}\right)^{\frac{1}{\phi-1}}(1+\tau) \qquad (11.1.B)$$

2.12.2 The decision to adopt High Technology

Given that, in this case, the fixed technology costs are higher than the trade costs, a firm will never find it profitable to switch to high technology and decide not to export. Therefore, only a subset of exporters will upgrade to high technology. They will be those exporters whose increase in domestic and export sales due to their adoption of high technology will enable them to pay the fixed technology costs. This condition is given by: $\pi_{dh}(\varphi_{xh}^*) + \;\pi_{xh}(\varphi_{xh}^*) = \pi_{dl}(\varphi_{xh}^*) + \pi_{xl}(\varphi_{xh}^*)$

$$\frac{\left[r_{dh}(\varphi_{xh}^*)+r_{xh}(\varphi_{xh}^*)\right]-\left[r_{dl}(\varphi_{xh}^*)+r_{xl}(\varphi_{xh}^*)\right]}{\phi} = \delta f_t \Rightarrow \;\; \varphi_{xh}^{*\phi-1} = \frac{f_t}{\left[1+(1+\tau)^{1-\phi}\right]\left[c_h^{1-\phi}-c_l^{1-\phi}\right]}\;\frac{\phi}{\Psi} \qquad (10.2.B)$$

The productivity cutoff to acquire high technology is represented by "φ_{xh}^*". The value of (φ_{xh}^*) as a function of (φ_{dl}^*) is given by (9.B) and (10.2.B):

$$\varphi_{xh}^* = \varphi_{dl}^*\left(\frac{\delta f_t}{f}\right)^{\frac{1}{\phi-1}}\left[\left[\left(\frac{c_h}{c_l}\right)^{1-\phi}-1\right]\left[1+(1+\tau)^{1-\phi}\right]\right]^{\frac{1}{1-\phi}} \qquad (11.2.B)$$

The specific condition for the partitioning of firms by export and technology status, which ensures that $\varphi_{xh}^* > \varphi_{xl}^* > \varphi_{dl}^*$ is: $\frac{\delta f_t}{\left[1+(1+\tau)^{1-\phi}\right]\left[\left(\frac{c_h}{c_l}\right)^{1-\phi}-1\right]} > (1+\tau)^{\phi-1}\,\delta f_x > f \qquad$ (11'.B)

This condition establishes that adopting high technology is more expensive than exporting and thereby suggests that only the most productive exporters can upgrade their technology. The weighted productivity average of each group of firms ($\widetilde{\varphi_{dl}}, \widetilde{\varphi_{xl}}, \widetilde{\varphi_{xh}}$) is defined using the same type of weighted average function defined in equations 12.A -16.A (Appendix 2 details the aggregation).

2.13 Labor Market Equilibrium and the Skill Premium

In the open economy equilibrium, exporters producing with low and high technology will increase their skilled and unskilled labor demand to produce for the foreign market. These demands are determined similarly to (18.A) and (19.A), taking into account the domestic demand for final goods (C_{dl}, C_{dh}) and the exporting firms' foreign demand for final goods (C_{xl}, C_{xh}). Equation 17.A remains unchanged (17.A=17.B).

$$l_{xi} = \frac{[C_{xi}+C_{di}]}{\varphi} c_i^{\frac{1}{1-\alpha}} (w_l)^{\frac{1}{\alpha-1}} \qquad (18.B)$$

$$h_{xi} = \frac{[C_{xi}+C_{di}]}{\varphi} c_i^{\frac{1}{1-\alpha}} (w_h)^{\frac{1}{\alpha-1}} (a_h)^{\frac{\alpha}{1-\alpha}} \qquad (19.B) \qquad \text{Where } i = \{l, h\} \qquad a_h > 1 \text{ if } i = h$$

Like (20.A) and (21.A), the overall national demand for unskilled and skilled labor is determined by aggregating the firms' individual demands. Here, we have to take into account firms producing in the domestic market and both types of exporting firms (see Appendix 2 for a presentation of the aggregate demands).

$$L^d = \int_{\varphi_{dl}^*}^{\varphi_{xl}^*} N_{dl} l_{dl}(\varphi) \mu_{dl}(\varphi) d\varphi + \int_{\varphi_{xl}^*}^{\varphi_{xh}^*} N_{xl} l_{xl}(\varphi) \mu_{xl}(\varphi) d\varphi + \int_{\varphi_{xh}^*}^{\infty} N_{xh} l_{xh}(\varphi) \mu_{xh}(\varphi) d\varphi \qquad (20.B)$$

$$H^d = \int_{\varphi_{dl}^*}^{\varphi_{xl}^*} N_{dl} h_{dl}(\varphi) \mu_{dl}(\varphi) d\varphi + \int_{\varphi_{xl}^*}^{\varphi_{xh}^*} N_{xl} h_{xl}(\varphi) \mu_{xl}(\varphi) d\varphi + \int_{\varphi_{xh}^*}^{\infty} N_{xh} h_{xh}(\varphi) \mu_{xh}(\varphi) d\varphi \qquad (21.B)$$

The aggregate relative skilled labor supply and demand jointly determine the skill premium.

$$\frac{H^s}{L^s} = \frac{H^d}{L^d} \qquad \Rightarrow \omega = g(\frac{H^s}{L^s}, a_h, N_{dl}, N_{xl}, N_{xh}, \widetilde{\varphi_{dl}}, \widetilde{\varphi_{xl}}, \widetilde{\varphi_{xh}}) \qquad (22.B)$$

2.14 Open Economy Equilibrium Conditions

As in the closed economy equilibrium, we obtain an analytical solution for the productivity, technological and export cutoffs using a Pareto distribution of productivity draws (see Appendix 2). The equilibrium level of the productivity cutoff is determined by the FE, the new ZCP and LMC conditions, just as in the closed economy equilibrium. FE remains unchanged. Under the ZCP condition for the open economy equilibrium, we have to take into account the average profits of low- and high-technology exporters[11].

FE: $\widetilde{\pi} = \frac{\delta f_E}{\left(1-G(\varphi_{dl}^*)\right)}$ (23.B)

ZCP:$\widetilde{\pi} = \pi_{dl}(\widetilde{\varphi_{dl}})\rho_{dl} + \rho_{xl}\left[\pi_{dl}(\widetilde{\varphi_{xl}}) + \pi_{xl}(\widetilde{\varphi_{xl}})\right] + \rho_{xh}\left[\pi_{dh}(\widetilde{\varphi_{xh}}) + \pi_{xh}(\widetilde{\varphi_{xh}})\right]$ (24.B)

[11] The variables "$\rho_l, \rho_{xh}, \rho_{xl}, \rho_x$" represent the probabilities of being a low technology firm (ρ_l), an exporting high technology firm (ρ_{xh}), an exporting low technology firm (ρ_{xl}) and finally an exporting firm (ρ_x)(See Appendix 2).

ZCP=FE $\quad \varphi_{dl}^{*} = f(a_h, \omega, f_E, f, f_x, f_t, \tau, \delta)$

LMC $\quad \frac{H^s}{L^s} = \frac{H^d}{L^d} \quad \Rightarrow \omega = g(\frac{H^s}{L^s}, a_h, f, \tau, f_x, f_t, \delta)$

Proposition 4: *Under Assumption 1 and the partitioning condition of open economy (eq. 11'.B), there exists a unique costly trade equilibrium cutoff (φ_{dl}^{*}).*

Proof. *See Appendix 2*•

Capital Market and Global Accounting Conditions: [12]

$$K = N_{dl} f + N_{xl}\left(f + \delta f_x\right) + N_{xh}\left(f + \delta f_x + \delta f_t\right) + N_E f_E \tag{25.B}$$

$$w_h H + w_l L + K = R \tag{26.B}$$

$$N = \frac{w_h H + w_l L + K}{[\widetilde{\pi} + f + \delta f_x \rho_{xl} + (\delta f_x + \delta f_t)\rho_{xh}]\phi} \tag{27.B}$$

3 The model's findings: the impact of trade liberalization

This section looks at the impact of trade liberalization on firms' decisions. The reduction in variable trade costs affects both the extensive margin of trade (the number of exporters) and the extensive margin of technology adoption (the number of high-technology firms).

Variable trade costs affect firms' decisions in a number of ways. The first two mechanisms are the selection effects in the domestic and foreign markets, as presented by Melitz (2003). The entry of the most productive foreign exporters onto the domestic market reduces all the firms' domestic profits, prompting the exit of the least productive firms. Trade integration, on the other hand, raises export profits and has a positive impact on the extensive margin of trade.

Proposition 5: *Under Assumption 1 and the partitioning condition of open economy (eq. 11'.B), average domestic profits of low technology firms are an increasing function of trade variable costs, while average export profits are a decreasing function of trade variable costs:* $\frac{\partial \rho_l \pi_l(\widetilde{\varphi_l})}{\partial \tau} > 0$; $\frac{\partial \rho_{xl} \pi_{xl}(\widetilde{\varphi_{xl}})}{\partial \tau} < 0$.

Proof. *See Appendix 2*•

This model sets out to introduce yet another channel based on the effects of trade on the extensive margin of technology adoption and its impact on the skill premium. The increase in export profitability creates incentives to upgrade technology. Therefore the most productive low-technology exporters adopt high technology and raise their relative demand for skilled labor.

Proposition 6: *Under Assumption 1 and the partitioning condition of open economy (eq. 11'.B), both the aggregate relative demand of skilled labor and the skill premium are decreasing functions of trade variable costs:*$\frac{\partial \left(\frac{H}{L}\right)^d}{\partial \tau} < 0 \Rightarrow \frac{\partial \omega}{\partial \tau} < 0$

Proof. *See Appendix 2*•

The last trade liberalization channel is the skill premium effect. In the general equilibrium, an upturn in the skill premium has a different impact on firms' decisions depending on their intensity in skilled

[12] Both conditions have to take into account trade costs.

and unskilled labor. However, this is a second-order effect stemming from the increase in the extensive margin of technology induced by selection. The low-technology unskilled-intensive firms benefit from the reduction in the relative unskilled labor wage (skill premium appreciation) compared with the most productive, skilled-intensive workers.

Proposition 7: *Under Assumption 1 and the partitioning condition of open economy (eq. 11'.B), average profits of low technology firms are an increasing function of the relative skilled per unit cost and thereby, of the skill premium, while average profits of high technology firms are a decreasing function of the skill premium:* $\frac{\partial \rho_l \pi_l(\widetilde{\varphi_l})}{\partial \frac{c_h}{c_l}(\omega)} > 0$; $\frac{\partial \rho_{xl} \pi_{xl}(\widetilde{\varphi_{xl}})}{\partial \tau} > 0$; $\frac{\partial \rho_{xh} \pi(\widetilde{\varphi_{xh}})}{\partial \frac{c_h}{c_l}(\omega)} < 0$

Proof. *See Appendix 2*•

Opposite forces affect both the production and technology cutoff: (1) the foreign competition and export selection effect, and (2) the skill premium effect. In order to determine which effect dominates, I run simulations of the impact of trade variable costs reduction on the equilibrium productivity cutoff taking into account the variations of the skill premium (See Appendix 2 and 3)[13]. Under the specific partitioning condition, the effects of trade reforms are quite unambiguous. Given that the increase in skill premium is a second-order effect, the net effect of trade reforms on the productivity cutoff is negative (Graph 1 in Appendix 3). The impact of variable trade costs is unambiguous and positive for the extensive margin of trade. New unskilled-intensive firms find it profitable to start exporting. Lastly, the net effect of trade liberalization on the extensive margin of technology is also positive. The increase in export profitability offsets the increase in the skill premium (Graph 2).

Compared to a model of homogeneous firms, this model predicts that: (1) A reduction in variable trade costs encourages only those who are already exporters to upgrade their technology; **(2)**Only the new high-technology exporters increase their relative demand for skilled labor.

4 Empirical evidence

4.1 Data and descriptive analysis

This section provides some evidence in support of the theoretical model's predictions and key assumption, namely that advanced technology is skill biased. This evidence draws on a database of Chilean plants provided by the ENIA Survey, a comprehensive manufacturing census covering all plants with more than 10 employees from 1979 to 1999[14]. Given that Chile is a developing country highly dependent on imported capital equipment and intermediate inputs, we consider that the most appropriate proxies for high technology are foreign technology measures. These measures comprise expenditure on imported

[13]In order to find the equilibrium value of the skill premium, I used the "FindRoot" command of Matematica which uses a root-finding algorithm. The results remain robust for different parameters values well established in the literature (See Appendix 3)

[14]The data used covers value-added, investment in capital equipment, imported inputs, foreign technology assistance, skilled and unskilled labor, and the share of skilled and unskilled labor in the wage bill. Export sales are reported from 1990 onwards. The plants' TFP is estimated by Bas and Ledezma (2007) based on the semi-parametric estimations by Levinsohn and Petrin (2003). Several specific sector-level deflators (Isic-3dig Rev2 1992) are applied to value-added, technological measures, materials and investment.

inputs and foreign technological assistance (FTA). Table 5 (Appendix 4) summarizes the variables and data requirements.

We use two measures of variable trade costs from the Trade and Production Database (World Bank and CEPII). The first is a measure of export border effects at the two-digit industry level between Chile and its main trading partners (1990-1999), estimated by Bas and Ledezma (2007) using a gravity model based on Fontagné, Mayer and Zignago (2005). The second is an average of import tariffs at the three-digit industry level (1991-1999) set by Chile's main trading partners. The average reduction of export border effect in the period is 20% and the one of average import tariff is 7% (Figure 4, Appendix 4)[15].

Table 6 (Appendix 4) summarizes the firms' main characteristics (3,900 plants per year). Exporters (31%) are larger[16], more productive (higher TFP), more skilled and capital intensive and use more FTA and imported inputs than non-exporters (69%). However, the percentage of non-exporters using FTA (3%) and imported inputs (11%) is very low. The features of the open economy equilibrium described in the previous section fit the descriptive evidence for the case of Chile. In order to test the assumption of heterogeneous firms in terms of productivity levels, we estimate the impact of export status (continuing, new, switchers and exiting exporters) on the plants' TFP. Table 7 (Appendix 4) reports on these findings. Once we have controlled for initial size, FDI and financial constraint indicators (column 4), only continuing, new exporters and switchers are more productive than those firms that sell solely on the domestic market. Among the exporters, the most productive are those that exported throughout the entire period. Continuing exporters are 28% more productive than non-exporters, while new exporters and switchers are 17% more productive. Those firms using foreign technology are more productive (31%) than the ones using domestic technology (column 5).

Our analysis of growth in the relative skilled labor demand and skill premium uses the decomposition approach developed by Machin and Van Reenen (1998) (Tables 8 and 9 Appendix 4). From 1979 to 1999, the relative demand for skilled labor rose 20% at the three-digit industry level. This increase is entirely explained by the within-industry variation. The between indicator is negative and extremely small [17]. During the debt crisis (1979-1986), skill intensity rose to 37% at the two-digit industry level. A full 26% of this increase is explained by the within estimator, while only 11% is explained by the between indicator. In the 1990s, there was also a rise in the relative demand for skilled labor, which is entirely explained by the within estimator. Similar findings hold for relative skilled wages in all periods.

4.2 Testing the assumption: foreign technology skill-biased

Since we only have data on the cost of skilled and unskilled labor (wage bill share), there is an endogeneity issue between the relative skilled labor demand and the skill premium. We therefore use the minimization cost function approach instead of a CES approach to test whether foreign technology is complementary

[15] Latin American countries, the European Union and the USA. Since there is no data available on tariffs in 1994 and 1997, we take the average of 1991-1993 and 1996-1999.

[16] Size classification: large firms have more than 150 workers, medium firms have more than 50 and up to 149 workers and small firms have more than 10 and up to 49.

[17] Similar results hold at 2 digit industry level and at the firm level

with skilled labor[18]. In this framework, firms minimize the cost of both skilled and unskilled labor assuming that capital stock is quasi-fixed. The translog cost function is:

$$(\mathrm{I})S_{it} = \beta_1 + \beta_y \ln(VA_{it}) + \beta_k \ln(K_{it}/VA_{it}) + \beta_T(TECH_{it}) + \beta_s IND + \beta_t YEAR + \epsilon_{it}$$

Dependant variable S_{it} is the share of skilled workers in the wage bill; K is the stock of capital; VA is value-added; TECH is a technology indicator equal to one if the firm reports having used imported inputs or FTA; and ϵ_{it} is an unobserved component. As in previous literature (see Machin and Van Reenen (1998) and Pavcnik (2002)), we consider that capital and value-added are not affected by the current wage bill share of skilled workers. In the case of capital, this is a realistic assumption since although investment could be correlated with the relative demand for skilled labor, investment in the current period does not enter the capital stock until the new period. Indeed capital stock will be independent of the unobserved shocks that influence the wage bill share of skilled workers. In the case of value-added, this variable is correlated with the share of skilled labor. To address this issue, we also use the lagged value-added in the estimations. Finally, we do not consider the skill premium due to the endogeneity issues. Since it is very hard to find good instruments for the relative wage of skilled labor and this is beyond the scope of the present section, we introduce three-digit industry and year dummies instead of relative wages. Introducing plant fixed effects controls for size effects.

The coefficient of interest is β_T. If TECH is complementary with skilled labor, we expect a positive and significant coefficient. Table 1 presents the findings of the fixed-effect regressions for the entire period (1979-1999) for the full sample (column 1) and three sub-samples of trade orientation (export oriented, import competing and non-trade sector[19]). After controlling for plant heterogeneity, industry and year indicators, the coefficient of the technology indicator is positive and highly significant. The value of β_T is higher for the firms selling on the foreign market (2.8%) than for the import-competing and non-trade firms (1.4% and 1.3%). Using firm level data of Argentina, Bustos (2005) finds that the growth of technology spending has a positive impact on the change in skilled upgrading for all firms.

We then run similar regressions using data on export sales for 1990-1999. We add four dummy variables to equation (I) to indicate the export status of the plants (continuing, new, exiting exporters and switchers[20])). The omitted variable in this regression corresponds to non-exporting firms. Table 2 presents the findings of OLS regressions with Hubert White standard errors clustered at plant level. The first column shows that technology was complementary with skilled labor in the 1990s (12.7%). We then control for the plants' productivity levels in the previous period and their foreign status (FDI indicator)[21].In columns 3, 4 and 5, we introduce the export status of the firms. The wage bill share of skilled labor is higher for all exporting firms compared with non-exporters. Moreover, the results of

[18]The author's PhD dissertation also estimates the log of the relative demand for skilled labor derived from equation 17.A

[19]Three-digit industry level plants with more than 15% of exports in their total production are classified as exported-oriented plants, while those with over a 15% import penetration indicator are classified as import-competing plants. The rest are considered to be non-trade plants. See Pavcnik (2002) for further details concerning this classification.

[20]See the classification in Table 5 in Appendix 4

[21]To control for the presence of multinational firms, a dummy variable equal to one is introduced when the percentage of foreign capital is higher than 50%

column 3 show that continuing exporters (8.4%) have higher skill intensity than new exporters (4.8%), exiting exporters (5%) and switchers (4%). When we control for past productivity levels, the coefficients are still significant but the values are lower.

[Table 1 and 2 about here]

4.3 Testing the predictions of the model

Prediction 1: The impact of trade liberalization on technology adoption

In the theoretical model, there are three groups of firms: (1) low-technology domestic firms (the least productive), (2) low-technology exporters, and (3) high-technology exporters (the most productive). The model's first prediction concerns the impact of trade liberalization on the extensive margin of technology adoption. A reduction in variable trade costs encourages continuing exporters to switch to more advanced technology, while the least productive exporters do not have enough profits to upgrade their technology. This prediction is tested by estimating the impact of a reduction in export barriers on the growth in foreign technology expenditure using the following framework:

(II) $lnTECH_{it} = \delta_1 + \delta_2(Export) + \delta_3(BX) + \delta_4(BX * Export) + \delta_c Z_{it} + \epsilon_{it}$

Where TECH is foreign technology expenditure; BX is the export barrier (or average import tariffs among Chile's main trading partners) at two- (three-) digit industry level, which varies across time; export is a vector of the dummy variables indicating the export status of the plants; and Z_{it} is a vector of the control variables[22].The omitted categories are non-exporters, the year 1990 (1991) and sector 29 (390) (other industries).

Equation (II) disentangles the growth in foreign technology expenditure due to changes in trade costs depending on the export status of the firm. We are mainly interested in the estimates of the vector coefficient δ_4. These are the coefficients of the interaction terms between export barriers and export status. A negative and significant coefficient is expected, meaning that a reduction in trade costs triggers a greater increase in foreign technology expenditure by exporters compared with non-exporters. The results of the estimation of equation (II) by OLS with standard errors clustered at plant level are presented in Table 3. The first three columns of Table 3 present the results with the export border effect, while the last three columns are based on the average import tariffs. In columns 1 and 3, we control by initial firm size and capital intensity. Within the same industry, already-exporting firms have a higher level of foreign technology than non-exporters after a reduction in trade barriers.

[Table 3 about here]

These results might be capturing other factors that could affect the change in foreign technology spending such as multinational firms or financial liberalization. In order to control for these two possible

[22]The control variables are plant size (measured by staff numbers in the initial year), capital intensity in the initial year, an FDI indicator and one of the credit constraints. "Financial" is a dummy variable equal to one if the plant reports having paid a loan tax in year "t" indicating that they are not subject to financial constraints. Industry affiliation (three-digit ISIC level) and year dummies are also introduced.

competing explanations, we introduce an indicator of FDI in the previous year (columns 2 and 5) and a financial indicator (columns 3 and 6), which identifies plants without credit constraints. Not surprisingly, the coefficients of FDI (0.577/0.558) and credit indicators (0.277/0.294) are positive and significant. However, after controlling by means of these alternative explanations the coefficients of the interaction terms between continuing exporters, the export barriers are still negative and significant. The average reduction of export border effect in the period is 20% and the one of average import tariff is 7%. Therefore, compared with non-exporters, continuing exporters raise their foreign technology expenditure after trade liberalization from a range of 4% (interaction with BX in column 3) to 7% (interaction with tariffs in column 6).

Using a different empirical specification (without interactions between export status and export barriers), Bustos (2005) also tests the impact of firms' export status on technology spending for Argentina. She finds that both new and continuing exporters have a higher level of technology spending than non exporters and that the change in technology spending is only significant for new exporters (43%)[23]. In a recent work, Bustos (2007) shows that the reduction of Brazilian's tariffs increases technology spending of all Argentinean firms by 0.20 log points. For both sub-samples of non exporters and exporters in the first year, she finds that firms upgrade technology after the reduction of export tariffs. For the case of Chile, when we introduce specific interactions between firms' export status and export barriers, we find that only continuing exporters upgrade technology.

Prediction 2: The impact of trade liberalization on the relative skilled labor demand

This model also predicts that, after trade liberalization, exporters producing with high technology will raise their relative demand for skilled labor. Since more advanced technology is complementary with skilled labor, exporters that upgrade technology following trade reform will also upgrade skilled labor. The second prediction posits that exporters that adopt high (foreign) technology increase their relative demand for skilled labor following a reduction in variable trade costs. We test this prediction using a similar methodology to that used in the previous section. We estimate the effect of a reduction in variable trade costs on the relative demand for skilled labor by firm export status.

$$\text{(III)} \ln\left(\frac{H_{it}}{L_{it}}\right) = \lambda_1 + \lambda_2(Export) + \lambda_3(BX) + \lambda_4(BX * Export) + \lambda_5 Z_{it} + e_{it}$$

The dependant variable is the number of skilled workers over unskilled workers ones $\left(\frac{H_{it}}{L_{it}}\right)$, BX is the export barrier, "'Export"' indicates the export status of plants and Z_{it} is a vector of the same plants' characteristics of the previous regressions[24]. Table 4 reports the estimations of equation (IV) by OLS with Huber White standard errors clustered at plant level. After controlling for the plant's initial productivity, capital intensity and foreign status, a reduction in export barriers has a significant positive effect on continuing exporters' relative demand for skilled labor compared with non-exporters (columns 3 and 6).

[23]When there is a significant reduction of export barriers (as in the case of Argentina at the beginning of the nineties) the theoretical framework also predicts that new exporters upgrade technology. Bustos's findings confirm this prediction.

[24]TThe omitted categories are non-exporters, the year 1990 (1991) and the sector 29 (390) (other industries).

Differences in skill upgrading between exporters and firms selling only on the domestic market increase as export barriers decrease. The trade-liberalization-induced increase in the relative demand for skilled labor by continuing exporters compared with non-exporters ranges from 2% (with both export barriers measures). This magnitude is similar to the findings of Bustos (2005) for Argentina. In her empirical specification (without export barriers), she finds that both continuing and new exporters increase their skill intensity faster (1.2 percentage points) than never exporting firms.

[Table 4 about here]

5 Conclusions

This paper explores the changes in the extensive margin of technology adoption and its effect on wage inequalities following trade liberalization. The mechanism is based on the impact of the technology-upgrading decision on the relative demand for skilled labor and hence on the skill premium. In terms of policy implications, a reduction in variable trade costs raises the number of firms selling abroad and encourages the most productive firms to switch to high technology. This enhances the relative demand for skilled labor and boosts the skill premium. The main contribution of this paper to the existing literature is to propose a general equilibrium model that links trade, firms' technology choice and wage inequalities in a framework of heterogeneous firms. This theoretical framework also explains the extensive empirical evidence: firms selling on foreign markets are not only more productive, but also use modern technologies and are more skill-intensive than firms selling only on the domestic markets. We provide evidence in support of the model's key assumption and predictions, drawing on plant level panel data for Chile's manufacturing sector.

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6 Appendix 1: closed economy equilibrium

The The relative skill per unit cost is an increasing function of the skill premium (equation 8.A):

$$\frac{\partial \frac{c_h}{c_l}}{\partial \omega} = \left(\frac{1-\alpha}{\alpha}\right)\left(\left(\frac{c_h}{c_l}\right)^{\frac{\alpha}{1-\alpha}}\right)^{\frac{1-\alpha}{\alpha}-1}\left[\frac{\left(\frac{\alpha}{1-\alpha}\right)(\omega)^{\frac{\alpha}{1-\alpha}-1}\left[(a_h)^{\frac{\alpha}{1-\alpha}}-1\right]}{\left[(\omega)^{\frac{\alpha}{1-\alpha}}+(a_h)^{\frac{\alpha}{1-\alpha}}\right]^2}\right]$$

$$\frac{\partial \frac{c_h}{c_l}}{\partial \omega} > 0 \qquad \text{since } (a_h)^{\frac{\alpha}{1-\alpha}} - 1 > 0 \qquad \text{and} \qquad 0 < \alpha < 1$$

Aggregation. Using price rule (eq. 3.A) and plugging it into the aggregate price index yields:

$$P^{1-\phi} = \left(\frac{\phi}{\phi-1}\right)^{1-\phi}(c_l)^{1-\phi}\left[N_l\left(\widetilde{\varphi}_l\right)^{\phi-1} + N_h\left(\frac{c_h}{c_l}\right)^{1-\phi}\left(\widetilde{\varphi_h}\right)^{\phi-1}\right] = N^{\frac{1}{1-\phi}}p\left(\widetilde{\varphi_T}\right)$$

Where: $p\left(\widetilde{\varphi_T}\right) = \frac{\phi}{\phi-1}\frac{c_l}{\widetilde{\varphi_T}}$ $\qquad \widetilde{\varphi_T}^{\phi-1} = \frac{1}{N}\left[N_l\left(\widetilde{\varphi}_l\right)^{\phi-1} + N_h\left(\frac{c_h}{c_l}\right)^{1-\phi}\left(\widetilde{\varphi_h}\right)^{\phi-1}\right]$

Aggregate Revenu

$$R = N_l\int_{\varphi_l^*}^{\varphi_h^*} r_l(\varphi)\mu_l(\varphi)d\varphi + N_h\int_{\varphi_h^*}^{\infty} r_h(\varphi)\mu_h(\varphi)d\varphi$$

$$R = N_l r_l(\widetilde{\varphi}_l) + N_h r_l(\widetilde{\varphi_h})\left(\frac{c_h}{c_l}\right)^{1-\phi} \qquad \text{Where} \qquad r_h(\widetilde{\varphi_h}) = r_l(\widetilde{\varphi_h})\left(\frac{c_h}{c_l}\right)^{1-\phi}$$

$$R = N\underbrace{\left[\frac{N_l}{N}r_l(\widetilde{\varphi}_l) + \frac{N_h}{N}r_l(\widetilde{\varphi_h})\left(\frac{c_h}{c_l}\right)^{1-\phi}\right]}_{r(\widetilde{\varphi_T})} = Nr\left(\widetilde{\varphi_T}\right)$$

Averages productivities assuming Pareto distribution. In keeping with Melitz and Ghironi (2005) and Melitz and Ottaviano (2005), we assume that productivity draws are distributed according to a Pareto distribution $g(\varphi) = \frac{k(\varphi_{\min})^k}{(\varphi)^{k+1}}$ with a lower bound $\varphi_{\min}$ and a shape parameter k indexing the dispersion of productivity levels among firms. Since I assume that $\varphi_{\min} = 1$ and the condition that ensures a finite mean of firm size is $k > \phi - 1$. The cumulative distribution function is $G(\varphi_i) = 1 - \left(\frac{\varphi_{\min}}{\varphi_i}\right)^k$.

Average productivity of firms producing with low technology

$\widetilde{\varphi}_l \equiv \upsilon\varphi_l^* \left[\frac{1-(\xi)^{-k+\phi-1}}{1-\xi^{-k}}\right]^{\frac{1}{\phi-1}}$ if $\varphi_l^* < \varphi < \varphi_h^*$

Where $\upsilon = \left[\frac{k}{k-(\phi-1)}\right]^{\frac{1}{\phi-1}}$ $\xi = \left(\frac{\delta f_t}{f}\right)^{\frac{1}{\phi-1}} \left[\left(\frac{c_h}{c_l}\right)^{1-\phi} - 1\right]^{\frac{1}{1-\phi}}$

Average productivity of firms producing with high technology. $\widetilde{\varphi}_h \equiv \upsilon\varphi_h^*$ if $\varphi > \varphi_h^*$

Determination of probabilities:. $\rho_l = 1 - \frac{1-G(\varphi_h^*)}{1-G(\varphi_l^*)} = 1 - \left(\frac{\varphi^*}{\varphi_h^*}\right)^k$ $\rho_h = \frac{1-G(\varphi_h^*)}{1-G(\varphi_l^*)} = \left(\frac{\varphi^*}{\varphi_h^*}\right)^k$

Labor Market Condition: Plugging firms' final good demands (1.A) into (18.A) and (19.A) and using (4.A) to express c_l, c_h, firms' demand of skilled (h_l, h_h) and unskilled labor is:

$$l_i = \left(\frac{P}{p_i}\right)^{\phi} \frac{C}{\varphi} \left(\left(\frac{\omega}{a_h}\right)^{\frac{\alpha}{\alpha-1}} + 1\right)^{-\frac{1}{\alpha}} \text{(18.A')} \; ; \; h_i = \left(\frac{P}{p_i}\right)^{\phi} \frac{C}{\varphi a_h} \left(\left(\frac{a_h}{\omega}\right)^{\frac{\alpha}{\alpha-1}} + 1\right)^{-\frac{1}{\alpha}} \text{(19.A')}$$

Where $i = \{l, h\}$ $a_h > 1$ if $i = h$

Plugging firms' prices (3.A) into (18.A') and (19.A') and then into aggregate skilled and unskilled labor demands using (20.A) and (21.A), we obtain the aggregate relative demand for skilled labor (22.A).

Proof of Proposition 1: Determination of closed economy equilibrium.

Proof. LMC (22.A), FE (23.A) and ZCP (24.A) conditions jointly determine the equilibrium cutoff level (φ_l^*). In order to obtain this cutoff, we plug into eq. 24.A the averages productivities, the technology cutoff (eq. 11.A) and the probabilities using assumption 1:

$$\frac{\delta f_E}{(1-G(\varphi_l^*))} = \frac{1}{N}\left[\frac{1}{\phi}\left[N_l \int_{\varphi^*}^{\varphi_h^*} r_l(\varphi)\mu_l(\varphi)d\varphi + N_h \int_{\varphi_h^*}^{\infty} r_h(\varphi)\mu_h(\varphi)d\varphi\right] - Nf - N_h f_t\right]$$

Replacing $N_l = \rho_l N$, $N_h = \rho_h N$, $r_l = \Psi c_l^{1-\phi}\varphi_i^{\phi-1}, r_h = \Psi c_h^{1-\phi}\varphi_i^{\phi-1}; \Psi = P^{\phi-1}R\left(\frac{\phi}{\phi-1}\right)^{1-\phi}$

$$\frac{\delta f_E}{(1-G(\varphi_l^*))} = \left[\frac{\Psi}{\phi}\left[\rho_l c_l^{1-\phi}\widetilde{\varphi}_l^{\,\phi-1} + \rho_h c_h^{1-\phi}\widetilde{\varphi}_h^{\,\phi-1}\right] - (f + \rho_h f_t)\right]$$

Using equation (9.A) to determine $\frac{\Psi}{\phi} = f \;\; c_l^{\phi-1}\varphi_l^{*1-\phi}$, so as to express average profits as a function of the productivity cutoff, yields:

$$\varphi_l^{*k}\delta f_E = \left[\left[\rho_l\left(\frac{\widetilde{\varphi}_l}{\varphi_l^*}\right)^{\phi-1} + \rho_h\left(\frac{c_l}{c_h}\right)^{\phi-1}\left(\frac{\widetilde{\varphi}_h}{\varphi_l^*}\right)^{\phi-1} - 1\right] f - \rho_h \delta f_t\right]$$

$$\varphi_l^* = \left[\frac{f}{\delta f_E}(\upsilon)^{\phi-1} + \left[\left[\left(\frac{c_h}{c_l}\right)^{1-\phi} - 1\right]^{\frac{k}{\phi-1}} \frac{f_t}{f_E}\left(\frac{\delta f_t}{f}\right)^{\frac{k}{1-\phi}}\left[(\upsilon)^{\phi-1} - 1\right]\right] - \frac{f}{\delta f_E}\right]^{\frac{1}{k}} \text{(28.A)}$$

Since the relative skilled labor unit cost $\left(\frac{c_h}{c_l}\right)$ depends on the skill premium, equations 28.A and 22.A (LMC) determine the equilibrium production cutoff.

Proof of Proposition 2: We partially differentiate equation 28.A with respect to $\frac{c_h}{c_l}(\omega)$, in order to analyze the impact of an exogenous increase in the skill premium on the productivity cutoff. Partially differentiating (28.A) we find $\frac{\partial\varphi_l^*}{\partial\frac{c_h}{c_l}(\omega)} < 0$.

$$\frac{\partial\varphi_l^*}{\partial\frac{c_h}{c_l}(\omega)} = (-1)\left(\varphi_l^{*k}\right)^{\frac{1}{k}-1}\left[\left(\frac{c_h}{c_l}\right)^{1-\phi}-1\right]^{\frac{k}{\phi-1}-1}\left(\frac{c_h}{c_l}\right)^{-\phi}\left[\frac{f_t}{f_E}\left(\frac{\delta f_t}{f}\right)^{\frac{k}{1-\phi}}\left[(\upsilon)^{\phi-1}-1\right]\right] \quad (29.A)$$

$$\frac{\partial\varphi_l^*}{\partial\frac{c_h}{c_l}(\omega)} < 0 \qquad \text{since } \left(\frac{c_l}{ch}\right)^{\phi-1} > 1 \text{ and } (\upsilon)^{\phi-1} > 1$$

Proof of Proposition 3: Partially differenciating (11.A) with respect to $\frac{c_h}{c_l}(\omega)$, we find $\frac{\partial\varphi_h^*}{\partial\frac{c_h}{c_l}(\omega)} > 0$

$$\frac{\partial\varphi_h^*}{\partial\frac{c_h}{c_l}(\omega)} = \frac{\varphi_h^*}{\varphi_l^*}\left[\frac{\partial\varphi_l^*}{\partial\left(\frac{c_h}{c_l}\right)} + \varphi_l^*\left[\left(\frac{c_h}{c_l}\right)^{1-\phi}-1\right]^{-1}\left(\frac{c_h}{c_l}\right)^{-\phi}\right] \qquad (30.A)$$

We can demostrate that $\frac{\partial\varphi_h^*}{\partial\frac{c_h}{c_l}(\omega)} > 0$ since the term in brakets in (30.A) is positive. Plugging (29.A) $\frac{\partial\varphi_l^*}{\partial\frac{c_h}{c_l}(\omega)}$ into (30.A), the term in brakets in (30.A) can be expressed as follows:

$$\varphi_l^{*k} > \left[\left(\frac{c_h}{c_l}\right)^{1-\phi}-1\right]^{\frac{k}{\phi-1}}\left[\frac{f_t}{f_E}\left(\frac{\delta f_t}{f}\right)^{\frac{k}{1-\phi}}\left[(\upsilon)^{\phi-1}-1\right]\right]$$

Using (28.A): $\frac{f}{\delta f_E}\left[(\upsilon)^{\phi-1}-1\right] > 0$

This result holds since $\frac{f}{\delta f_E} > 0$ and $(\upsilon)^{\phi-1}-1 > 0$. Indeed, $\frac{\partial\varphi_h^*}{\partial\left(\frac{c_h}{c_l}\right)} > 0$

7 Appendix 2: Open Economy Equilibrium

Averages productivities assuming Pareto distribution.

$$\mu_{dl}(\varphi) = \frac{g(\varphi)}{G(\varphi_{xl}^*)-G(\varphi_{dl}^*)} \qquad \text{if} \quad \varphi_{dl}^* < \varphi_i < \varphi_{xl}^* \qquad (12.B)$$

$$\mu_{xl}(\varphi) = \frac{g(\varphi)}{G(\varphi_{xh}^*)-G(\varphi_{xl}^*)} \qquad \text{if} \quad \varphi_{xl}^* < \varphi_i < \varphi_{xh}^* \qquad (13.1.B)$$

$$\mu_{xh}(\varphi) = \frac{g(\varphi)}{1-G(\varphi_{xh}^*)} \qquad \text{if} \quad \varphi_i > \varphi_{xh}^* \qquad (13.2.B)$$

Average productivity of low technology firms (non exporters and exporters)

$$\widetilde{\varphi}_l \equiv \upsilon\varphi_{dl}^*\left[\frac{1-(\varepsilon)^{-k+\phi-1}}{1-\varepsilon^{-k}}\right]^{\frac{1}{\phi-1}} \qquad \text{Where } \upsilon = \left[\frac{k}{k-(\phi-1)}\right]^{\frac{1}{\phi-1}} \qquad (14.B)$$

$$\varepsilon = \left(\frac{f_t}{f}\right)^{\frac{1}{\phi-1}}\left[\left[\left(\frac{c_h}{c_l}\right)^{1-\phi}-1\right]\left[1+(1+\tau)^{1-\phi}\right]\right]^{\frac{1}{1-\phi}}$$

Average productivity of non exporters firms producing with low technology

$$\widetilde{\varphi_{dl}}^{\phi-1} \equiv \frac{1}{G(\varphi_{xl}^*)-G(\varphi_{dl}^*)}\int_{\varphi_{dl}^*}^{\varphi_{xl}^*}(\varphi)^{\phi-1}g(\varphi)d\varphi = \upsilon\varphi_{dl}^*\left[\frac{1-(\vartheta)^{-k+\phi-1}}{1-\vartheta^{-k}}\right]^{\frac{1}{\phi-1}}$$

$$\text{if} \quad \varphi_{dl}^* < \varphi < \varphi_{xl}^* \qquad \text{Where} \quad \vartheta = \left(\frac{f_x}{f}\right)^{\frac{1}{\phi-1}}(1+\tau)$$

Average productivity of exporters producing with low technology

$$\left(\widetilde{\varphi_{xl}}\right)^{\phi-1} \equiv \frac{1}{G(\varphi_{xh}^*)-G(\varphi_{xl}^*)}\int_{\varphi_{xl}^*}^{\varphi_{xh}^*}(\varphi)^{\phi-1}g(\varphi)d\varphi = \upsilon\varphi_{xl}^*\left[\frac{1-(\Omega)^{-k+\phi-1}}{1-\Omega^{-k}}\right]^{\frac{1}{\phi-1}}$$

if $\quad \varphi_{xl}^* < \varphi < \varphi_{xh}^* \qquad$ Where $\qquad \Omega = \frac{\varepsilon}{1+\tau}\left(\frac{f}{f_x}\right)^{\frac{1}{\phi-1}}$

Average productivity of high technology firms (exporters)

$$\widetilde{\varphi_{xh}}^{\phi-1} \equiv \frac{1}{1-G(\varphi_{xh}^*)}\int_{\varphi_{xh}^*}^{\infty}(\varphi)^{\phi-1}g(\varphi)d\varphi \equiv \upsilon\varphi_{xh}^* \qquad \text{if} \qquad \varphi > \varphi_{xh}^* \quad (15.B)$$

Determination of probabilities

$\rho_l = 1-\varepsilon^{-k}; \qquad \rho_x = \left(\frac{\varphi_{dl}^*}{\varphi_{xl}^*}\right)^k = \vartheta^{-k};\ \rho_{dl} = \left[1-\vartheta^{-k}\right];$

$\rho_{xl} = \left(\frac{\varphi_{dl}^*}{\varphi_{xl}^*}\right)^k - \left(\frac{\varphi_{dl}^*}{\varphi_{xh}^*}\right)^k = \left[\vartheta^{-k}-\varepsilon^{-k}\right] \qquad \rho_{xh} = \left(\frac{\varphi_{dl}^*}{\varphi_{xh}^*}\right)^k = \varepsilon^{-k}$

Using price rule defined in equation 3.B and plugging it into aggregate price index yields

$P = N^{\frac{1}{1-\phi}}p\left(\widetilde{\varphi_T}\right) \qquad$ Where $p\left(\widetilde{\varphi_T}\right) = \frac{\phi}{\phi-1}\frac{c_l}{\widetilde{\varphi_T}}$

$$\widetilde{\varphi_T}^{\phi-1} = \frac{1}{N}\left[N_l\left(\widetilde{\varphi_l}\right)^{\phi-1} + N_{xh}\left(\widetilde{\varphi_{xh}}\right)^{\phi-1}\left(\frac{c_h}{c_l}\right)^{1-\phi}\left[1+(1+\tau)^{1-\phi}\right] + (1+\tau)^{1-\phi}N_{xl}\left(\widetilde{\varphi_{xl}}\right)^{\phi-1}\right] \quad (16.B)$$

Labor Market Condition

Plugging firms' final good demands (1.B) into (18.B) and (19.B), individual demand for skilled (h_{xl}, h_{xh}) and unskilled labor (l_{xl}, l_{xh}) by exporting firms with low and high technology is:

$$l_{xi} = \left(\frac{P}{p_{di}}\right)^{\phi}\frac{C}{\varphi}\left[1+(1+\tau)^{1-\phi}\right]\left(\left(\frac{\omega}{a_h}\right)^{\frac{\alpha}{\alpha-1}}+1\right)^{-\frac{1}{\alpha}} \qquad (18.B')$$

$$h_{xi} = \left(\frac{P}{p_{di}}\right)^{\phi}\frac{C}{\varphi a_h}\left[1+(1+\tau)^{1-\phi}\right]\left(\left(\frac{a_h}{\omega}\right)^{\frac{\alpha}{\alpha-1}}+1\right)^{-\frac{1}{\alpha}} \qquad (19.B')$$

Exporters have to hire both types of workers to produce for both domestic and foreign markets. Plugging prices (3.B) into (18.B) and (19.B) and then into aggregate skilled and unskilled labor demand using (20.B) and (21.B), we obtain the aggregate relative demand for skilled labor (22.B), which determines the skill premium.

$$\frac{H^s}{L^s} = \omega^{\frac{1}{\alpha-1}}\left[\frac{1+(a_h)^{\frac{\alpha}{1-\alpha}}\left[\frac{N_{xh}\widetilde{\varphi_{xh}}^{\phi-1}\left[1+(1+\tau)^{1-\phi}\right]}{N_{dl}\widetilde{\varphi_{dl}}^{\phi-1}+N_{xl}\widetilde{\varphi_{xl}}^{\phi-1}\left[1+(1+\tau)^{1-\phi}\right]}\right]A}{1+\left[\frac{N_{xh}\widetilde{\varphi_{xh}}^{\phi-1}\left[1+(1+\tau)^{1-\phi}\right]}{N_{dl}\widetilde{\varphi_{dl}}^{\phi-1}+N_{xl}\widetilde{\varphi_{xl}}^{\phi-1}\left[1+(1+\tau)^{1-\phi}\right]}\right]A}\right] \qquad (22.B)$$

Proof of Proposition 4: Determination of the open economy equilibrium. Like in the closed economy equilibrium, LMC (eq. 22.B), FE and ZCP conditions jointly determine the equilibrium cutoff level. Plugging in the ZCP condition the following variables: $\widetilde{\varphi_{dl}}, \widetilde{\varphi_{xl}}, \widetilde{\varphi_{xh}}, \rho_l, \rho_{xl}\ \rho_{xh}$ and $\varphi_{xl}^*, \varphi_{xh}^*$, we obtain the production cutoff level as a function of the skill premium and the parameters of the model.

$\widetilde{\pi} = \rho_l \pi_{dl}(\widetilde{\varphi}_l) + \rho_{xl}\pi_{xl}(\widetilde{\varphi_{xl}}) + \rho_{xh}\left[\pi_{dh}(\widetilde{\varphi_{xh}}) + \pi_{xh}(\widetilde{\varphi_{xh}})\right]$

$\frac{\delta f_E}{1-G(\varphi^*_{dl})} = f\left[\rho_l\left(\frac{\widetilde{\varphi}_l}{\varphi^*_{dl}}\right)^{\phi-1} + \rho_{xl}\left(\frac{\widetilde{\varphi_{xl}}}{\varphi^*_{dl}}\right)^{\phi-1}(1+\tau)^{1-\phi} + \rho_{xh}\left(\frac{\widetilde{\varphi_{xh}}}{\varphi^*_{dl}}\right)^{\phi-1}\left(\frac{c_h}{c_l}\right)^{1-\phi}\left[1+(1+\tau)^{1-\phi}\right]\right]$
$-\left[f + \rho_x f_x + \rho_{xh} f_t\right]$

Following similar steps to those in the closed economy equilibrium, we obtain, in this case:

$$\varphi^{*k}_{dl}\delta f_E = \frac{f\left[\left(\frac{c_h}{c_l}\right)^{1-\phi}\left[1+(1+\tau)^{1-\phi}\right]-1\right]}{(\upsilon)^{1-\phi}\varepsilon^{k-(\phi-1)}} + \frac{f_x\left[\frac{1-(\Omega)^{-k+\phi-1}}{1-\Omega^{-k}}\right]}{(\upsilon)^{1-\phi}\left[\vartheta^{-k}-\varepsilon^{-k}\right]^{-1}} + \frac{f}{\left[(\upsilon)^{\phi-1}-1\right]^{-1}} - \frac{f_t}{\varepsilon^k} - \frac{f_x}{\vartheta^k} \quad (28.B)$$

$\rho_l\pi_{dl}(\widetilde{\varphi}_l) = f\upsilon^{\phi-1} - f\upsilon^{\phi-1}(\varepsilon)^{-k+\phi-1} - f$
$\rho_{xl}\pi_{xl}(\widetilde{\varphi_{xl}}) = f_x(\upsilon)^{\phi-1}\left[\vartheta^{-k} - \varepsilon^{-k}\right]\left[\frac{1-(\Omega)^{-k+\phi-1}}{1-\Omega^{-k}}\right] - \vartheta^{-k} f_x$

$\rho_{xh}\pi(\widetilde{\varphi_{xh}}) = \rho_{xh}\left[\pi_{dh}(\widetilde{\varphi_{xh}}) + \pi_{xh}(\widetilde{\varphi_{xh}})\right] = \frac{\varepsilon^{\phi-1-k}\left(\frac{c_h}{c_l}\right)^{1-\phi} f\upsilon^{\phi-1}}{\left[1+(1+\tau)^{1-\phi}\right]^{-1}} - \varepsilon^{-k} f_t$

Proof of Proposition 5: The impact of trade variable costs on average profits.

Partially differenciating $\rho_l\pi_l(\widetilde{\varphi}_l)$with respect to τ

$\frac{\partial\rho_l\pi_l(\widetilde{\varphi}_l)}{\partial\tau} = \left[k-(\phi-1)\right] f\upsilon^{\phi-1}(\varepsilon)^{-k+\phi-2}\frac{\partial\varepsilon}{\partial\tau} > 0$
$\frac{\partial\varepsilon}{\partial\tau} = \varepsilon\left[(1+\tau)^{\phi} + (1+\tau)\right]\left[1 + \frac{\partial\frac{c_h}{c_l}}{\partial\tau}\frac{\left[(1+\tau)^{\phi}+(1+\tau)\right]}{\left[\left(\frac{c_l}{c_h}\right)^{\phi-1}-1\right]}\right] > 0$

When $|1| > \left|\frac{\partial\frac{c_h}{c_l}}{\partial\tau}\frac{\left[(1+\tau)^{\phi}+(1+\tau)\right]}{\left[\left(\frac{c_l}{c_h}\right)^{\phi-1}-1\right]}\right| \Rightarrow \frac{\partial\varepsilon}{\partial\tau} > 0 \Rightarrow \frac{\partial\rho_l\pi_l(\widetilde{\varphi}_l)}{\partial\tau} > 0$

A reduction of trade variable costs increases foreign competition and thereby reduces domestic profits of low technology unskilled intensive firms.

Partially differenciating $\rho_{xl}\widetilde{\pi}_{xl}(\varphi_{xl})$ with respect to τ

$\frac{\partial\rho_{xl}\widetilde{\pi}(\varphi_{xl})}{\partial\tau} = -kf_x(\upsilon)^{\phi-1}\left[\frac{1-(\Omega)^{-k+\phi-1}}{1-\Omega^{-k}}\right]\left[\vartheta^{-k-1}\frac{\partial\vartheta}{\partial\tau} + \varepsilon^{-k-1}\frac{\partial\varepsilon}{\partial\tau}\right] +$
$f_x(\upsilon)^{\phi-1}\left[\vartheta^{-k} - \varepsilon^{-k}\right]\left[\frac{\frac{\partial\Omega}{\partial\tau}\Omega^{-2k+\phi-2}\left[\left[k-(\phi-1)\right]\left(\Omega^k-1\right) - k\left(\Omega^{k-(\phi-1)}-1\right)\right]}{\left[1-\Omega^{-k}\right]^2}\right]$

i) $\frac{\partial\vartheta}{\partial\tau} > 0$
ii) $\frac{\partial\varepsilon}{\partial\tau} > 0$

iii) $\frac{\partial\Omega}{\partial\tau} = K\frac{\left[1+(1+\tau)^{1-\phi}\right]^{\frac{1}{1-\phi}}}{(1+\tau)^2}\left[\frac{1}{\left[(1+\tau)^{\phi-1}+1\right]} - 1 + \frac{\frac{\partial\frac{c_h}{c_l}}{\partial\tau}(1+\tau)^{-1}}{\left[\left(\frac{c_h}{c_l}\right)^{1-\phi}-1\right]\left(\frac{c_h}{c_l}\right)^{\phi}}\right] < 0$

Since $K = \left(\frac{f_t}{f_x}\right)^{\frac{1}{\phi-1}}\left[\left(\frac{c_h}{c_l}\right)^{1-\phi} - 1\right]^{\frac{1}{1-\phi}} > 0$; $\frac{\partial\frac{c_h}{c_l}}{\partial\tau} < 0$; $\frac{1}{\left[(1+\tau)^{\phi-1}+1\right]} < 1 \Rightarrow \frac{\partial\Omega}{\partial\tau} < 0$

We can demostrate that $\frac{\partial \rho_{xl}\widetilde{\pi}(\varphi_{xl})}{\partial \tau} < 0$. First, the first term is negative since $\frac{\partial \vartheta}{\partial \tau} > 0$ and $\frac{\partial \varepsilon}{\partial \tau} > 0$ and the second term is also negative since $\frac{\partial \Omega}{\partial \tau} < 0$,$\left[\vartheta^{-k} - \varepsilon^{-k}\right] > 0$ and $[k - (\phi - 1)]\left(\Omega^{k} - 1\right) > k\left(\Omega^{k-(\phi-1)} - 1\right)$. A reduction of trade variable costs increases export profits of low technology exporters.

Partially differenciating $\rho_{xh}\widetilde{\pi}(\varphi_{xh})$with respect to τ

$$\frac{\partial \rho_{xh}\widetilde{\pi}(\varphi_{xh})}{\partial \tau} = \frac{\partial \varepsilon}{\partial \tau}\varepsilon^{-k-1}kf_t\left[1 - \frac{1}{\left[1-\left(\frac{c_h}{cl}\right)^{\phi-1}\right]}\right] + \frac{(1-\phi)f\frac{(1+\tau)^{\phi}+(1+\tau)}{\left(\frac{c_h}{c_l}\right)}\left[1+\frac{\partial\frac{c_h}{c_l}}{\partial \tau}\frac{(1+\tau)^{\phi}+(1+\tau)}{\left(\frac{c_h}{c_l}\right)}\right]}{\upsilon^{1-\phi}\left(\frac{c_h}{c_l}\right)^{\phi}\varepsilon^{k-\phi+1}\left[1+(1+\tau)^{1-\phi}\right]^{-1}}$$

Since $\frac{1}{\left[1-\left(\frac{c_h}{cl}\right)^{\phi-1}\right]} > 1$ the first term is negative. The second term will be also negative since $(\phi > 1)$ and when $|1| > \left|\frac{\partial\frac{c_h}{c_l}}{\partial \tau}\frac{(1+\tau)^{\phi}+(1+\tau)}{\left(\frac{c_h}{c_l}\right)}\right|$.

Proof of proposition 6: The impact of trade costs reduction on the aggregate relative skilled labor demand. By plugging into the equation (22.B) the average productivity levels and the number of firms (solved using the Pareto distribution), the aggregate relative skilled labor demand can be expressed as follows:

$$\frac{H^d}{L^d} = \omega^{\frac{1}{\alpha-1}}\left[\frac{1+a_h^{\frac{\alpha}{1-\alpha}}AX}{1+AX}\right]$$

Where: $X(\tau) = \frac{\varepsilon^{-k+\phi-1}\left[1+(1+\tau)^{1-\phi}\right]}{\left[1-(\vartheta)^{-k+\phi-1}\right]+\left[\vartheta^{-k}-\varepsilon^{-k}\right]\left[\frac{1-(\Omega)^{-k+\phi-1}}{1-\Omega^{-k}}\right]\vartheta^{\phi-1}\left[1+(1+\tau)^{1-\phi}\right]}$; $A = \left(\frac{c_h}{c_l}\right)^{-\phi}\left(\frac{(\omega)^{\frac{\alpha}{\alpha-1}}+1}{\left(\frac{\omega}{a_h}\right)^{\frac{\alpha}{\alpha-1}}+1}\right)^{\frac{1}{\alpha}}$

Note that $\varepsilon(\tau), \vartheta(\tau), \Omega(\tau)$ are also functions of τ. These variables are defined in the previous section.

To determine whether the aggregate relative skilled labor demand is a decreasing function of variable trade costs, we first analyze $\frac{H^d}{L^d}$ as a function of X .

i) $\lim\limits_{X\to\infty}\frac{H^d}{L^d}(\tau) = \omega^{\frac{1}{\alpha-1}}a_h^{\frac{\alpha}{1-\alpha}}$

ii) $\lim\limits_{X\to 0}\frac{H^d}{L^d}(\tau) = \omega^{\frac{1}{\alpha-1}}$

iii) $\lim\limits_{X\to\frac{-1}{A}}\frac{H^d}{L^d}(\tau) = \infty$

First we demostrate that $X(\tau) > 0$ under the partitioning condition:

$$\frac{\delta f_t}{\left[1+(1+\tau)^{1-\phi}\right]\left[\left(\frac{c_h}{c_l}\right)^{1-\phi}-1\right]} > \delta f_x\left(1+\tau\right)^{\phi-1} > f$$

The numerator of $X(\tau)$ is positive ($c_l > c_h$ and $\phi > 1$). Moreover, under this partitioning condition the denominator will also be positive since:

(1)$\delta f_x\left(1+\tau\right)^{\phi-1} > f$

$1 > \left(\frac{f}{\delta f_x}\right)^{\frac{k-(\phi-1)}{\phi-1}}\left(\frac{1}{(1+\tau)}\right)^{k-(\phi-1)}$

$1 - (\vartheta)^{-k+\phi-1} > 0$

(2) $\frac{\delta f_t}{\left[\left[\left(\frac{c_h}{c_l}\right)^{1-\phi}-1\right]\left[1+(1+\tau)^{1-\phi}\right]\right]} > \delta f_x (1+\tau)^{\phi-1}$

$\left(\frac{f}{\delta f_x}\right)^{\frac{k}{\phi-1}}\left(\frac{1}{1+\tau}\right)^{k} > \left(\frac{f}{\delta f_t}\right)^{\frac{k}{\phi-1}}\left[\left[\left(\frac{c_h}{c_l}\right)^{1-\phi}-1\right]\left[1+(1+\tau)^{1-\phi}\right]\right]^{\frac{k}{\phi-1}}$

$\vartheta^{-k} - \varepsilon^{-k} > 0$

(3) $\frac{\delta f_t}{\left[\left[\left(\frac{c_h}{c_l}\right)^{1-\phi}-1\right]\left[1+(1+\tau)^{1-\phi}\right]\right]} > \delta f_x (1+\tau)^{\phi-1}$

$1-\Omega^{-k+\phi-1} > 0$ and $1-\Omega^{-k} > 0$

Hence, $X(\tau)$ is positive and consequently $\frac{H^d}{L^d}$ is an increasing function of $X(\tau)$. Then we analyze $X(\tau)$ for $\tau = 0$ and $\tau = 1$, we can demostrate that $X(0) > X(1)$.. Under the partitioning condition of case 1, $X(\tau)$ is a decreasing function of τ : $\frac{\partial X}{\partial \tau} < 0$. Indeed, a reduction of τ will increase $X(\tau)$ and the rise in $X(\tau)$ will increase $\frac{H^d}{L^d}$. Therefore, the aggregate relative skilled labor demand is a decreasing function of trade variable costs :$\frac{\partial\left(\frac{H}{L}\right)^d}{\partial \tau} < 0$. Since the relative skilled labor supply is fixed, a reduction in variable trade costs will push up the aggregate relative skilled labor demand and hence raise the skill premium. $\frac{\partial \omega}{\partial \tau} < 0$.

Proof of Proposition 7: The impact of the relative skilled labor cost ($\frac{c_h}{c_l}(\omega)$) on average profits. Partially differenciating the $\pi_{dl}(\widetilde{\varphi_l})\rho_l$ with respect to $\frac{c_h}{c_l}$

$$\frac{\partial \pi_{dl}(\widetilde{\varphi_l})\rho_l}{\partial \frac{c_h}{c_l}(\omega)} = [k-(\phi-1)]\, f\upsilon^{\phi-1}(\varepsilon)^{-k+\phi-2}\,\frac{\partial \varepsilon}{\partial \frac{c_h}{c_l}} > 0$$

$$\frac{\partial \varepsilon}{\partial \frac{c_h}{c_l}(\omega)} = \frac{\left(\frac{f_t}{f\left[1+(1+\tau)^{1-\phi}\right]}\right)^{\frac{1}{\phi-1}}}{\left[\left(\frac{c_h}{c_l}\right)^{1-\phi}-1\right]^{\frac{\phi}{\phi-1}}\left(\frac{c_h}{c_l}\right)^{\phi}} > 0$$

An increase in the skill premium means a reduction of the relative wage of unskilled labor and an increase of the relative per unit cost of skilled labor. This appreciation of $\frac{c_h}{c_l}$ benefits the least productive unskilled intensive firms raising their domestic profits.

Partially differenciating $\rho_{xl}\pi_{xl}(\widetilde{\varphi_{xl}})$ with respect to $\frac{c_h}{c_l}$

$$\frac{\partial \rho_{xl}\pi_{xl}(\widetilde{\varphi_{xl}})}{\partial \frac{c_h}{c_l}(\omega)} = \frac{\partial \varepsilon}{\partial \frac{c_h}{c_l}}\,\frac{kf_x\left[\frac{1-\Omega^{-k+\phi-1}}{1-\Omega^{-k}}\right]}{\varepsilon^{k+1}(\upsilon)^{1-\phi}} + \frac{f_x\left[\vartheta^{-k}-\varepsilon^{-k}\right]}{(\upsilon)^{1-\phi}}\left[\frac{\frac{\partial\Omega}{\partial\tau}\left[[k-(\phi-1)]\Omega^{-k+\phi-2}\left(1-\Omega^{-k}\right)-k\Omega^{-k-1}\left(1-\Omega^{-k+\phi-1}\right)\right]}{\left[1-\Omega^{-k}\right]^2}\right]$$

Where $$\frac{\partial \Omega}{\partial \frac{c_h}{c_l}(\omega)} = \frac{\left(\frac{f_t}{f_x 1+(1+\tau)^{1-\phi}}\right)^{\frac{1}{\phi-1}}}{(1+\tau)\left[\left(\frac{c_h}{c_l}\right)^{1-\phi}-1\right]^{\frac{\phi}{\phi-1}}\left(\frac{c_h}{c_l}\right)^{\phi}} > 0$$

In the second term, the term in brackets is equal to $\frac{\frac{\partial\Omega}{\partial\tau}\Omega^{-2k+\phi-2}\left[[k-(\phi-1)]\left(\Omega^{k}-1\right)-k\left(\Omega^{k-(\phi-1)}-1\right)\right]}{\left[1-\Omega^{-k}\right]^2} > 0$

Since $\frac{\partial \varepsilon}{\partial \frac{c_h}{c_l}(\omega)} > 0$; $\quad \frac{\partial \Omega}{\partial \frac{c_h}{c_l}(\omega)} > 0 \quad \Rightarrow \quad \frac{\partial \rho_{xl}\pi_{xl}(\widetilde{\varphi_{xl}})}{\partial \frac{c_h}{c_l}(\omega)} > 0$

An increase in $\frac{c_h}{c_l}(\omega)$benefits unskilled intensive exporters raising also their export profits.

Partially differenciating $\rho_{xh}\pi(\widetilde{\varphi_{xh}})$ with respect to $\frac{c_h}{c_l}$

$$\frac{\partial \rho_{xh}\pi(\widetilde{\varphi_{xh}})}{\partial \frac{c_h}{c_l}} = \frac{\partial \varepsilon}{\partial \frac{c_h}{c_l}} k\varepsilon^{-k-1} \left[\frac{[-k+(\phi-1)]\varepsilon^{\phi-1} f \frac{\upsilon^{\phi-1}}{k} \left(\frac{c_l}{c_h}\right)^{\phi-1}}{\left[1+(1+\tau)^{1-\phi}\right]^{-1}} + 1 \right] + \frac{(1-\phi)\varepsilon^{\phi-1-k} f \upsilon^{\phi-1} \left(\frac{c_l}{c_h}\right)^{\phi}}{\left[1+(1+\tau)^{1-\phi}\right]^{-1}}$$

Since $\frac{\partial \varepsilon}{\partial \frac{c_h}{c_l}(\omega)} > 0$, $k > \phi - 1$, $\phi > 1$ and $\frac{c_l}{c_h} > 1$, both terms are negative: $\frac{\partial \rho_{xh}\pi(\widetilde{\varphi_{xh}})}{\partial \frac{c_h}{c_l}} < 0$

The appreciation of the skill premium and thereby of the relative skilled per unit cost hurts the most productive skilled intensive firms decreasing their domestic and export profits.

The impact of the relative skilled labor cost on the productivity cutoffs

$$\varphi_{dl}^{*k} \delta f_E = B(\tfrac{c_h}{c_l}, \tau) + G(\tfrac{c_h}{c_l}, \tau) + f\left[(\upsilon)^{\phi-1} - 1\right] - \frac{f_x}{\vartheta^k} \qquad (28\text{'.B})$$

Where $B(\frac{c_h}{c_l}, \tau) = f\,(\upsilon)^{\phi-1}\,\varepsilon^{-k+\phi-1}\left[\left(\frac{c_h}{c_l}\right)^{1-\phi}\left[1 + (1+\tau)^{1-\phi}\right] - 1\right]$

$G(\frac{c_h}{c_l}, \tau) = f_x\,(\upsilon)^{\phi-1}\left[\vartheta^{-k} - \varepsilon^{-k}\right]\left[\frac{1-(\Omega)^{-k+\phi-1}}{1-\Omega^{-k}}\right] - \varepsilon^{-k} f_t$

Partially differenciating (28.B) with respect to $\frac{c_h}{c_l}(\omega)$ yields

$$\frac{\partial \varphi_{dl}^{*}}{\partial \frac{c_h}{c_l}(\omega)} = \frac{\varphi_{dl}^{*(1-k)}}{k}\frac{1}{\delta f_E}\left[\frac{\partial B}{\partial \frac{c_h}{c_l}(\omega)} + \frac{\partial G}{\partial \frac{c_h}{c_l}(\omega)}\right]$$

(1) Partially differenciating B with respect to $\frac{c_h}{c_l}$ yields

$$\frac{\partial B}{\partial \frac{c_h}{c_l}(\omega)} = [-k + \phi - 1]\,\frac{\partial \varepsilon}{\partial \frac{c_h}{c_l}(\omega)}\,\frac{f\left[\left(\frac{c_h}{c_l}\right)^{1-\phi}\left[1+(1+\tau)^{1-\phi}\right]-1\right]}{\upsilon^{1-\phi}\varepsilon^{k-\phi+2}} + \frac{(1-\phi)\left[1+(1+\tau)^{1-\phi}\right]\varepsilon^{-k+\phi-1} f(\upsilon)^{\phi-1}}{\left[\left(\frac{c_h}{c_l}\right)^{1-\phi}\left[1+(1+\tau)^{1-\phi}\right]-1\right]\left(\frac{c_h}{c_l}\right)^{\phi}}$$

We can prove that $\frac{\partial B}{\partial \frac{c_h}{c_l}(\omega)} < 0$ since $\frac{\partial \varepsilon}{\partial \frac{c_h}{c_l}(\omega)} > 0$; $k > \phi - 1$ and $\phi > 1$.

(2) Partially differenciating G with respect to $\frac{c_h}{c_l}$ yields

$$\frac{\partial G}{\partial \frac{c_h}{c_l}(\omega)} = \frac{\partial \varepsilon}{\partial \frac{c_h}{c_l}(\omega)} k \left[\frac{f_x\left[\frac{1-(\Omega)^{-k+\phi-1}}{1-\Omega^{-k}}\right]}{\upsilon^{1-\phi}\left[\frac{\varepsilon^{k+1}}{\vartheta^k} - \varepsilon\right]} + f_t\right] + \frac{f_x\left[\vartheta^{-k} - \varepsilon^{-k}\right]}{(\upsilon)^{1-\phi}}\left[\frac{\frac{\partial \Omega}{\partial \tau}\Omega^{-2k+\phi-2}\left[[k-(\phi-1)]\left(\Omega^k - 1\right) - k\left(\Omega^{k-(\phi-1)} - 1\right)\right]}{[1-\Omega^{-k}]^2}\right]$$

Since $\frac{\partial \varepsilon}{\partial \frac{c_h}{c_l}(\omega)} > 0$; $\quad \frac{\partial \Omega}{\partial \frac{c_h}{c_l}(\omega)} > 0 \quad \Rightarrow \frac{\partial G}{\partial \frac{c_h}{c_l}(\omega)} > 0$

Both B and G depend on the skill premium and this variable is determined in the labor market equilibrium (equation 22.B). We run simulations of the equilibrium production cutoff which show $\frac{\partial B}{\partial \frac{c_h}{c_l}(\omega)} >$ $\frac{\partial G}{\partial \frac{c_h}{c_l}(\omega)}$ and thus $\frac{\partial \varphi_{dl}^{*}}{\partial \frac{c_h}{c_l}(\omega)} < 0$[25].

[25] These results remain robust for different parameters values well established in the literature: Consumers' elasticity of substitution: ϕ= 3 / 4 (Bernard et al., 2004); the elasticity of substitution between factors in the production function = 2 /2,5 (α =0,5/0,6) (Acemoglu ,2002); Pareto shape parameter k= 3,4 / 5. Following Bernard, Redding and Schott (2004): f_e= 1 / 3; f = 0,1 / 0,4; f_x= 0,1 / 0,5 and f_t= 0,8/ 2.

(3) Partially differenciating (11.1.B) with respect to $\frac{c_h}{c_l}$ yields

$$\frac{\partial\varphi_{xl}^*}{\partial\frac{c_h}{c_l}(\omega)} = \frac{\partial\varphi_{dl}^*}{\partial\frac{c_h}{c_l}(\omega)}\left(\frac{f_x}{f}\right)^{\frac{1}{\phi-1}}(1+\tau)$$

Since low technology exporters are unskilled intensive firms, the effect of the relative skilled per unit costs (and of the skill premium) on the extensive margin of trade (φ_{xl}^*) is similar to the impact on the extensive margin of production (φ_{dl}^*). An increase of the skill premium (the reduction of the relative unskilled wage) reduces the production and export cutoff: $\frac{\partial\varphi_{dl}^*}{\partial\frac{c_h}{c_l}(\omega)} < 0 \Rightarrow \frac{\partial\varphi_{xl}^*}{\partial\frac{c_h}{c_l}(\omega)} < 0$.

(4) Partially differenciating (11.2.B) with respect to $\frac{c_h}{c_l}$ yields

$$\frac{\partial\varphi_{xh}^*}{\partial\frac{c_h}{c_l}(\omega)} = \frac{\varphi_{xh}^*}{\left[\left(\frac{c_h}{c_l}\right)-\left(\frac{c_h}{c_l}\right)^{\phi}\right]}\left[1+\frac{\partial\varphi_{dl}^*}{\partial\frac{c_h}{c_l}(\omega)}\frac{\left[\left(\frac{c_h}{c_l}\right)-\left(\frac{c_h}{c_l}\right)^{\phi}\right]}{\varphi_{dl}^*}\right] > 0$$

Replacing $\frac{\partial\varphi_{dl}^*}{\partial\frac{c_h}{c_l}(\omega)}$; eq. 28.B: $\left|\varphi_{dl}^{*k}\delta f_E\right| > \left|\frac{\left[\frac{\partial B}{\partial\frac{c_h}{c_l}(\omega)}+\frac{\partial G}{\partial\frac{c_h}{c_l}(\omega)}\right]\left[\left(\frac{c_h}{c_l}\right)-\left(\frac{c_h}{c_l}\right)^{\phi}\right]}{k}\right|$ and $\frac{\partial\varphi_{xh}^*}{\partial\frac{c_h}{c_l}(\omega)} > 0$.The most productive high technology firms will suffer from an increase in the skill premium.

The net impact of trade variable costs on the productivity cutoffs

Partially differenciating (28.B) with respect to τ, taking into account $\frac{\partial\frac{c_h}{c_l}}{\partial\tau}$, yields

$$\frac{\partial\varphi_{dl}^*}{\partial\tau} = \frac{\varphi_{dl}^{*(1-k)}}{k}\frac{1}{\delta f_E}\left[\frac{\partial B(\tau)}{\partial\tau}+\frac{\partial G(\tau)}{\partial\tau}\right]$$

(1) Partially differenciating $B(\tau)$ with respect to τ yields

$$\frac{\partial B}{\partial\tau} = \frac{(-k+\phi-1)\varepsilon^{-k+\phi-2}\frac{\partial\varepsilon}{\partial\tau}f(\upsilon)^{\phi-1}}{\left[\left[\left(\frac{c_l}{ch}\right)^{\phi-1}\left[1+(1+\tau)^{1-\phi}\right]\right]-1\right]^{-1}} + \frac{(1-\phi)f}{(\upsilon)^{1-\phi}\varepsilon^{k-\phi+1}\left(\frac{c_h}{c_l}\right)^{\phi-1}}\left[\frac{1}{\left[1+(1+\tau)^{1-\phi}\right](1+\tau)^{\phi}}+\frac{\partial\frac{c_h}{c_l}}{\partial\tau}\frac{\left[1+(1+\tau)^{1-\phi}\right]}{\left(\frac{c_h}{c_l}\right)}\right]$$

Since $\frac{\partial\varepsilon}{\partial\tau} > 0$ and $k > \phi-1$ the first term is negative. The sing of the second term depends on the elasticity of relative per unit cost of skilled labor. The simulation results show that $\frac{\partial B}{\partial\tau} < 0$.

(2) Partially differenciating $G(\tau)$ with respect to τ yields

$$\frac{\partial G}{\partial\tau} = -kf_x(\upsilon)^{\phi-1}\left[\frac{1-(\Omega)^{-k+\phi-1}}{1-\Omega^{-k}}\right]\left[\vartheta^{-k-1}\frac{\partial\vartheta}{\partial\tau}+\varepsilon^{-k-1}\frac{\partial\varepsilon}{\partial\tau}\right]+$$
$$f_x(\upsilon)^{\phi-1}\left[\vartheta^{-k}-\varepsilon^{-k}\right]\left[\frac{\frac{\partial\Omega}{\partial\tau}\Omega^{-2k+\phi-2}\left[[k-(\phi-1)]\left(\Omega^k-1\right)-k\left(\Omega^{k-(\phi-1)}-1\right)\right]}{[1-\Omega^{-k}]^2}\right]+k\varepsilon f_t\frac{\partial\varepsilon}{\partial\tau}$$

We can demostrate that $\frac{\partial G}{\partial\tau} < 0$. First, the first term is negative since $\frac{\partial\vartheta}{\partial\tau} > 0$ and $\frac{\partial\varepsilon}{\partial\tau} > 0$. The second term is also negative since $\frac{\partial\Omega}{\partial\tau} < 0$,$\left[\vartheta^{-k}-\varepsilon^{-k}\right] > 0$ and $[k-(\phi-1)]\left(\Omega^k-1\right) > k\left(\Omega^{k-(\phi-1)}-1\right)$.

Finally, the last term is positive since $\frac{\partial\varepsilon}{\partial\tau} > 0$, but under the partitioning condition this term is smaller than the other two (See simulation results, Appendix 3).

Since $\frac{\partial B(\tau)}{\partial \tau} < 0$ and $\frac{\partial G(\tau)}{\partial \tau} < 0$, indeed $\frac{\partial \varphi_{dl}^{*}}{\partial \tau} < 0$. A reduction of trade variable costs (taking into account the impact of τ on $\frac{c_h}{c_l}(\omega)$) increases foreign competition and induces the exit of the least productive firms (raising the production cutoff).

(3) Partially differenciating (11.1.B) with respect to τ yields

$$\frac{\partial \varphi_{xl}^{*}}{\partial \tau} = \left(\frac{f_x}{f}\right)^{\frac{1}{\phi-1}} \left[\varphi_{dl}^{*} + \frac{\partial \varphi_{dl}^{*}}{\partial \tau}(1+\tau)\right] > 0$$

In order to see if $|\varphi_{dl}^{*}| > \left|\frac{\partial \varphi_{dl}^{*}}{\partial \tau}(1+\tau)\right|$ we replace $\frac{\partial \varphi_{dl}^{*}}{\partial \tau}$. Since $\left|\varphi_{dl}^{*k}\delta f_E\right| > \left|\frac{\left(\frac{\partial B}{\partial \tau}+\frac{\partial G}{\partial \tau}\right)(1+\tau)}{k}\right|$, indeed we can prove that $\frac{\partial \varphi_{xl}^{*}}{\partial \tau} > 0$.A reduction of trade variable costs allows the most productive domestic firms to enter the foreign market.

(4) Partially differenciating (11.2.B) with respect to τ yields

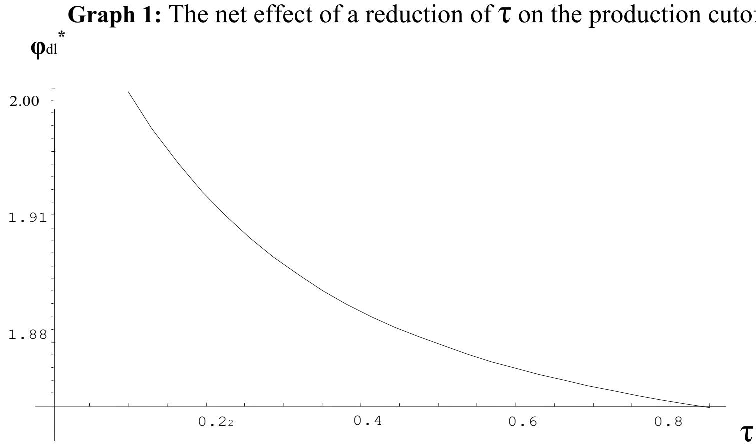
$$\frac{\partial \varphi_{xh}^{*}}{\partial \tau} = \varphi_{xh}^{*}\left[\frac{1}{\left[(1+\tau)^{\phi}+(1+\tau)\right]} + \frac{\partial \varphi_{dl}^{*}}{\partial \tau}\frac{1}{\varphi_{dl}^{*}}\right] > 0$$

Replacing $\frac{\partial \varphi_{dl}^{*}}{\partial \tau}$; eq. 28.B: $\left|\varphi_{dl}^{*k}\delta f_E\right| > \left|\frac{\left(\frac{\partial B}{\partial \tau}+\frac{\partial G}{\partial \tau}\right)\left[(1+\tau)^{\phi}+(1+\tau)\right]}{k}\right|$,indeed we can prove that $\frac{\partial \varphi_{xh}^{*}}{\partial \tau} > 0$. A reduction of trade variable costs allows the most productive low technology exporters to upgrade technology.

8 Appendix 3: Simulations results

Case 1: The impact of trade liberalization

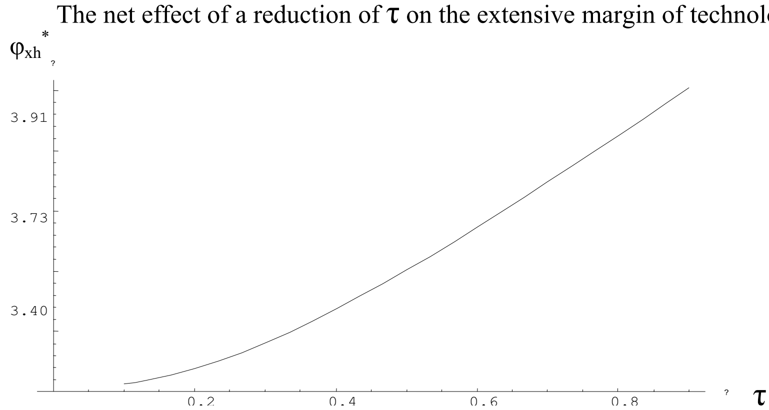
Graph 1: The net effect of a reduction of τ on the production cutoff



“Foreign competition effect” dominates over the “skill premium effect”: the least productive firms exit the market.

Graph 2:

The net effect of a reduction of τ on the extensive margin of technology



“Extensive margin of technology”: a reduction of trade frictions increases market shares and profits of all exporters allowing new firms to adopt high technology. The increase in export profitability compensates the negative impact of the raise in the skill premium on the technology adoption decision.

Partitioning condition:

$$\frac{\delta f_t}{\left[1+(1+\tau)^{1-\phi}\right]\left[\left(\frac{c_h}{c_l}\right)^{1-\phi}-1\right]} > (1+\tau)^{\phi-1}\delta f_x > f$$

Parameters values: These results remain robust for different parameters values well established in the literature: $\phi=3/4$ (Bernard et al., 2004); α=0.5/0.6 (Acemoglu ,2002); k =3,4/5. Following Bernard, Redding and Schott (2004): f_e=1/2; f=0,1/0,2; δf_x=0,2/0,3 and δf_t=0,9/1,25; a_h = 2/3.

9 Appendix 4: Empirical results

[Figure 4 about here]

Figure 4 (a):
Evolution of export barriers between Chile an its main trading partners
(UE, USA and latin American countries)

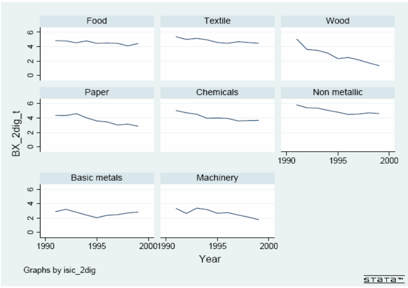
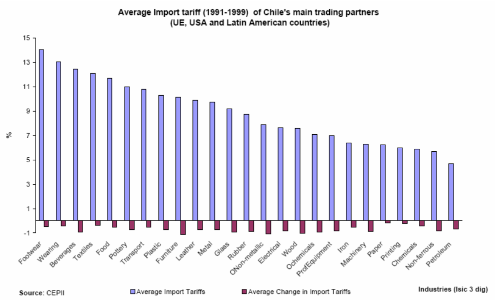


Figure 4 (b):



Source : Bas and Ledezma (2007)

Table 1: Fixed Effects regression. DV: Wage bill share of skilled labor (1979-1999)

	Full Sample	**Export Oriented**	**Import Competing**	**Non Traded**
ln VA(t-1)	0.035***	0.034***	0.038***	0.036***
	(0.001)	(0.002)	(0.002)	(0.003)
ln K_VA(t-1)	0.011***	0.011***	0.015***	0.007***
	(0.001)	(0.002)	(0.002)	(0.002)
TECH_ind	0.018***	0.028***	0.014***	0.013***
	(0.003)	(0.006)	(0.004)	(0.005)
Plant Ind, ISIC 3 dig and Year Ind	YES	YES	YES	YES
Number of Obs	43003	16923	15027	11026
R.Sq.	0.316	0.262	0.230	0.392

Note: Huber White Standard errors clustered by firm. The intercept is not reported
$^{*}p < 0.10$, $^{**}p < 0.05$, $^{***}p < 0.01$

Table 2: Dependant variable: Wage bill share of skilled labor (1990-1999)

	[M_1]	[M_2]	[M_3]	[M_4]	[M_5]
ln VA(t-1)	0.010***	0.010***	0.007***	0.039***	0.039***
	(0.002)	(0.002)	(0.002)	(0.003)	(0.003)
TECH_Ind	0.127***	0.124***	0.100***	0.064***	
	(0.006)	(0.006)	(0.006)	(0.006)	
Foreign Ind		0.072***	0.054***	0.040***	
		(0.014)	(0.014)	(0.013)	
cont_exp			0.084***	0.040***	0.039***
			(0.009)	(0.009)	(0.009)
new_cont			0.048***	0.022**	0.023**
			(0.011)	(0.010)	(0.010)
switchers			0.040***	0.017**	0.018**
			(0.009)	(0.008)	(0.008)
stop_exp			0.052***	0.033**	0.032**
			(0.015)	(0.015)	(0.015)
TFP(t-1)				0.094***	0.093***
				(0.005)	(0.005)
TECH_Ind(t-1)					0.065***
					(0.006)
FDI Ind(t-1)					0.042***
					(0.013)
ISIC 3 dig and Year Ind	YES	YES	YES	YES	YES
Number of Obs	19376	19376	19376	18612	18612
Adjusted R-Sq.	0.191	0.195	0.208	0.262	0.262

Note: Huber White Standard errors clustered by firm. The intercept is not reported
$^{*}p < 0.10$, $^{**}p < 0.05$, $^{***}p < 0.01$

Table 3: Prediction 1: The impact of TL on Technology Spending.
Dependant variable: Log of Technology Spending (1990-1999)

	BX_1	**BX_2**	**BX_3**	**Tariffs_1**	**Tariffs_2**	**Tariffs_3**
Border Effect Exporter	0.107	0.105	0.180*			
BX	(0.073)	(0.091)	(0.102)			
cont*BX	-0.165**	-0.205**	-0.195*			
	(0.083)	(0.100)	(0.101)			
new*BX	-0.144	-0.140	-0.123			
	(0.105)	(0.128)	(0.132)			
stop*BX	-0.100	-0.142	-0.159			
	(0.118)	(0.147)	(0.197)			
switchers*BX	-0.080	-0.046	-0.035			
	(0.089)	(0.109)	(0.104)			
Tariff_X				0.398**	0.372*	0.383*
				(0.186)	(0.202)	(0.200)
cont*TX				-0.943***	-0.948***	-0.946***
				(0.190)	(0.211)	(0.210)
new*TX				-0.377	-0.401	-0.425
				(0.248)	(0.271)	(0.259)
stop*TX				-0.970***	-0.937***	-0.939**
				(0.347)	(0.362)	(0.370)
switchers*TX				-0.178	-0.152	-0.304
				(0.214)	(0.243)	(0.236)
cont_exp	1.233***	1.397***	1.267***	2.645***	2.688***	2.590***
	(0.359)	(0.425)	(0.429)	(0.434)	(0.481)	(0.478)
new_cont	1.316***	1.303**	1.188**	1.605***	1.638***	1.644***
	(0.456)	(0.540)	(0.558)	(0.561)	(0.611)	(0.590)
switchers	0.792**	0.686	0.536	0.871*	0.808	1.053*
	(0.381)	(0.451)	(0.429)	(0.494)	(0.567)	(0.550)
stop_exp	0.853	1.070*	1.075	2.633***	2.587***	2.500***
	(0.528)	(0.631)	(0.851)	(0.791)	(0.828)	(0.833)
Employment_initial	0.941***	0.920***	0.904***	0.950***	0.929***	0.913***
	(0.037)	(0.041)	(0.041)	(0.038)	(0.041)	(0.041)
K_L_initial	0.265***	0.236***	0.254***	0.265***	0.240***	0.260***
	(0.038)	(0.043)	(0.040)	(0.040)	(0.044)	(0.041)
FDI Ind (t-1)		0.646***	0.577***		0.614***	0.558***
		(0.116)	(0.118)		(0.122)	(0.127)
Financial Ind (t-1)			0.277***			0.294***
			(0.076)			(0.078)
TFP initial			0.549***			0.548***
			(0.058)			(0.060)
ISIC 3 dig and Year Ind	YES	YES	YES	YES	YES	YES
Number of Obs	9500	6704	6619	8393	6468	6383
Adjusted R-Sq.	0.352	0.355	0.396	0.354	0.359	0.400

Note: Huber White Standard errors clustered by firm in parentheses

Note: The coefficient of the intercept is not reported. Import Tariffs of Chile were dropped

$^{*}p < 0.10$, $^{**}p < 0.05$, $^{***}p < 0.01$

Table 4: Prediction 2: The impact of TL on the relative skilled labor demand. Dependant variable: Skilled over unskilled labor (1990-1999)

	BX_1	**BX_2**	**BX_3**	**Tariffs_1**	**Tariffs_2**	**Tariffs_3**
Border Effect Exporter	-0.003	-0.011	-0.008			
BX	(0.015)	(0.019)	(0.021)			
cont*BX	-0.090***	-0.089**	-0.102***			
	(0.030)	(0.037)	(0.038)			
new*BX	-0.017	-0.011	-0.026			
	(0.035)	(0.042)	(0.045)			
stop*BX	0.001	-0.031	-0.031			
	(0.051)	(0.064)	(0.069)			
switchers*BX	-0.028	-0.030	-0.034			
	(0.028)	(0.032)	(0.033)			
Tariff_X				0.053	0.051	0.059
				(0.039)	(0.043)	(0.043)
cont*TX				-0.302***	-0.285***	-0.319***
				(0.072)	(0.082)	(0.082)
new*TX				-0.104	-0.139	-0.162
				(0.090)	(0.103)	(0.104)
stop*TX				-0.179	-0.242	-0.268*
				(0.131)	(0.147)	(0.147)
switchers*TX				-0.057	-0.044	-0.050
				(0.075)	(0.082)	(0.081)
cont_exp	0.395***	0.358**	0.331**	0.655***	0.593***	0.599***
	(0.131)	(0.157)	(0.161)	(0.169)	(0.193)	(0.193)
new_cont	0.145	0.086	0.107	0.279	0.330	0.348
	(0.148)	(0.173)	(0.186)	(0.202)	(0.234)	(0.236)
stop_exp	-0.018	0.091	0.032	0.372	0.495	0.498
	(0.215)	(0.261)	(0.281)	(0.298)	(0.333)	(0.333)
switchers	0.182	0.177	0.152	0.173	0.131	0.110
	(0.114)	(0.128)	(0.131)	(0.167)	(0.182)	(0.181)
TFP initial	0.148***	0.161***	0.164***	0.118***	0.124***	0.130***
	(0.014)	(0.016)	(0.016)	(0.014)	(0.016)	(0.016)
FDI Ind (t-1)		0.219***	0.172***		0.137**	0.097*
		(0.059)	(0.058)		(0.056)	(0.055)
Tariff_M			-0.270***			-0.311***
			(0.038)			(0.034)
K_L_initial			0.084***			0.074***
			(0.009)			(0.009)
ISIC 3 dig and Year Ind	YES	YES	YES	YES	YES	YES
Number of Obs	25992	18587	18587	22341	18204	18204
AAdjusted R-Sq.	0.093	0.093	0.103	0.123	0.125	0.133

Note: Huber White Standard errors clustered by firm in parentheses

Note: The coefficient of the intercept is not reported

$^{*}p < 0.10$, $^{**}p < 0.05$, $^{***}p < 0.01$

Table 5: Variables description

	[Variable]	[Data]
Employment	E	Total labour
Skilled labor	H	Non production workers: employees paid by commissions, administrative stuff, subcontract employees and other non production employees.
Unskilled labor	L	Production workers
Skill intensity	H/E	Non production workers over total labour
Relative skilled labor demand	H/L	Non production over production workers
Wage rate of skilled labor	Wh	Wages paid to non production workers over the number of non production workers hired
Wage rate of unskilled labor	Wl	Wages paid to production workers over the number of production workers hired
Wage bill shared of skilled labor	S	Wage bill of non production workers over total wage bill of production and non production workers
Value Added	VA	Sales minus variable inputs deflated by sectoral level deflators (Isic-3dig Rev 2 1992)
Capital labour ratio	K/L	Capital stock over total workers
Total Technology spending	TECH	Exdpenditures of imported inputs and FTA
Total factor productivity	TFP	Total factor productivity estimated using Levinsohn and Petrin methodology in Bas and Ledezma (2007)
Financial Indicator	Financial_Ind	Dummy variable equals to one if the plant reports having paid a loan tax in year "'t"'
Foreign Direct Investment	FDI_Ind	Dummy variable equal to one if the firm has more than 50% of foreign capital
Continuing exporters	Cont_exp	Dummy variable equal to one if the firm exports during the whole period
New exporters	New_cont	Dummy variable equal to one if the firm does not export at the beginning of the period and starts exporting afterwards
Stop exporting	Stop_exp	Dummy variable equal to one if the firm exports at the beginning of the period and stops exporting afterwards
Switchers	Switchers	Dummy variable equal to one if the firm enters and exits the foreign market more than once
Border Effect Exporter	BX	Export barriers at 2 digit industry level estimated by Bas and Ledezma (2007).

Table 6: Summary Statistics by Export Status (1990-1999)

	[Exporters]	[Non Exporters]
Number of Firms	31% (1196)	69% (2704)
Continuing exporters	12%	
New exporters	7%	
Stop exporting	3%	
Switchers	9%	
Size %		
Large (more 150 workers)	40%	6%
Medium (50-149 workers)	36%	20%
Small (10-49 workers)	24%	74%
TFP (Mean)	2740 (176)	1149 (23)
Employment (Mean)	202 (4)	55 (0.61)
Skill intensity (Mean)	0.30 (0.003)	0.25 (0.001)
Capital Intensity (Mean)	7838 (225)	2593 (46)
FTA (%)	14%	3%
Import share of inputs expenditure (%)	53%	11%
Type of Ownership Foreign	11%	1%

Note: Standard errors of means are reported in parentheses.

Table 7: Exporter Premia: TFP by export status. Dependant variable: TFP

	M1	**M2**	**M3**	**M4**	**M5**
cont_exp	0.429***	0.294***	0.293***	0.282***	0.208***
	(0.036)	(0.041)	(0.044)	(0.044)	(0.044)
new_cont	0.284***	0.208***	0.190***	0.176***	0.109**
	(0.043)	(0.044)	(0.046)	(0.046)	(0.046)
switchers	0.258***	0.200***	0.187***	0.173***	0.133***
	(0.033)	(0.034)	(0.035)	(0.035)	(0.034)
stop_exp	0.128*	0.043	-0.001	-0.014	-0.049
	(0.068)	(0.070)	(0.074)	(0.074)	(0.071)
Employment_initial		0.089***	0.072***	0.057***	0.025*
		(0.013)	(0.014)	(0.014)	(0.014)
FDI Ind(t-1)			0.160***	0.161***	0.140**
			(0.057)	(0.057)	(0.055)
Financial Ind (t-1)				0.112***	0.075***
				(0.021)	(0.021)
TECH Ind					0.313***
					(0.025)
ISIC 3dig IND	YES	YES	YES	YES	YES
Year IND					
Number of Obs	25990	25990	18588	18588	18588
Adjusted R-Sq.	0.367	0.372	0.397	0.400	0.415

Note: Huber White Standard errors clustered by firm in parentheses
Note: The coefficient of the intercept is not reported
$^{*}p < 0.10$, $^{**}p < 0.05$, $^{***}p < 0.01$

Table 8: Decomposition of Relative Demand of Skilled labor (H/L)

	[Total]	**[Between]**	**[Within]**	**[Within/Total]**
		1979-1999		
Industries at 2 digit	0,079	-0,014	0,093	1,182
Industries at 3 digit	0,202	-0,005	0,206	1,023
Firms	0,227	0,068	0,158	0,697
		1979-1986		
Industries at 2 digit	0,377	0,110	0,267	0,708
Industries at 3 digit	0,238	-0,033	0,272	1,140
Firms	0,317	0,173	0,143	0,452
		1990-1999		
Industries at 2 digit	0,056	0,001	0,055	0,983
Industries at 3 digit	0,068	0,002	0,066	0,969
Firms	0,044	-0,083	0,127	2,846

Table 9: Decomposition of Relative Skilled Wage

	[Total]	**[Between]**	**[Within]**	**[Within/Total]**
		1979-1999		
Industries at 2 digit	0,014	-0,008	0,022	1,549
Industries at 3 digit	0,324	0,041	0,283	0,873
Firms	1,518	0,464	1,054	0,694
		1979-1986		
Industries at 2 digit	0,127	0,002	0,124	0,980
Industries at 3 digit	0,518	-0,010	0,528	1,020
Firms	0,752	0,339	0,412	0,548
		1990-1999		
Industries at 2 digit	0,157	-0,038	0,195	1,245
Industries at 3 digit	0,563	-0,295	0,858	1,524
Firms	0,639	0,100	0,539	0,843