

The impact of trade reforms on the pattern of export specialization

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Abstract

This paper develops a dynamic inter-industry model of trade with heterogeneous sectors to analyze the impact of trade liberalization on the pattern of export specialization. Our model extends the work of Melitz (2003), incorporating endogenous labor productivity gains determined by investment in imported capital goods. Sectors are differentiated by the impact of this technology on labor efficiency. The new channel introduced by this model is based on changes of the price of imported capital equipment, which has a different effect on sectors depending on the reaction of labor productivity to the new technology. This new mechanism introduces two results. Firstly, the process of trade liberalization is biased towards sectors where imported investment has a higher impact on labor productivity. Secondly, a reduction of tariffs would have a little impact on export qualitative diversification in countries already highly open.

Keywords: trade reforms, firm heterogeneity, endogenous productivity gains, export specialization.

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1 Introduction

This paper analyzes the effect of trade liberalization on the pattern of export specialization. We focus on countries that specialize on sectors that benefit the most, in terms of productivity gains, from the incorporation of imported capital equipment. In sectors with these characteristics, labor tends to be substituted by capital. Since this substitution is more likely to occur in activities that have a relatively large endowment of unskilled labor, it can be reasonably associated to basic goods such as primary goods, natural resources or weak transformations of them. In this respect, this work helps to understand the persistence of export baskets mainly composed by basic goods in countries with a high dependence on technologies embodied in imported capital equipment.

The paper is based on recent work developed within the framework of the "new" new trade theory. In the context of this literature, Melitz (2003), Ghironi and Melitz (2004) and Bergin et al. (2005) assume productivity heterogeneity across firms to explain (1) differences between exporters and domestic sellers, and (2) the process of market share reallocation resulting from trade. Several empirical works, based on industry-specific samples, have provided support to these ideas, demonstrating that only the most productive firms are able to face the variable and fixed export costs and become exporters. Pavcnik (2001) measured the impact of trade reforms on the growth of total factor plant productivity in Chile during the late 1970s and early 1980s. She finds important differences between traded and non traded sector productivity and emphasizes the role played by the process of firm's exit. Bernard and Jensen (2001) for US, Clerides et al. (1998) for Colombia, Mexico and Morocco, and Aw et al. (1999) for Taiwan, concerning the reasons of this productivity gap, suggest an ex-ante self-selection process based on productivity rather than an increase in productivity after selling overseas. Bernard, Jensen and Schott (2003) measured the variation of trade costs across industries and over time for the US. They found out that aggregate industry productivity increases more rapidly as trade costs fall. This result is more robust in industries producing horizontally differentiated varieties and it remains qualitatively unchanged using two or four-digit SIC levels of industry aggregation.

While there is theoretical work analyzing why exporters are more productive than non exporters and how and why the reallocation process of trade takes place, the determinants of these differentials of productivity across sectors or firms have not received enough attention. Seen at a sector (industry) level this productivity differentials could come from technical differences associated to the nature of goods. To analyse the pattern of export specialization, we propose to take into account these sector differences using the conceptual framework of firm heterogeneity. This paper addresses this issue in the context of countries where technologies are imported and embodied in capital goods. In order to point out our arguments we consider the important process of trade reforms that took place in several developing countries.

As showed in graphs 1a and 1b (Annexe 1), in Asia and Africa trade liberalization begun at the early nineties and in Latin America during the eighties. In this context, the price of imported capital goods sled, while the amount of imported capital equipment exploded (Graphs 2a and 2b). In most of these countries, there was also a great growth of exports (Graph 3a). Particularly, in Latin America we can observe that the growth of exports is biased towards basic goods (Graph 3b). According to CEPAL's definition, these goods are the ones with a weaker degree of transformation in the production process. They include not only natural resources, but also some goods that are usually considered manufactures such as food or textile fabric.¹ In some Asian countries the pattern of export specialization in basic goods persists for years after the trade reforms are implemented as showed in graph 3c.²

Our argument is that, absent any industrial policy effort, sectors producing basic goods were able to increase their exports because they experienced significant productivity gains on account of the price reduction of imported capital goods. Given their greater endowment of unskilled labor, after a change in relative prices, these sectors obtain productivity gains by capital-labor substitution. Conversely, sectors producing goods with a higher degree of technological transformation are usually skilled labor intensive and, consequently, are stimulated by investment in R&D rather than by investment in capital equipment. In the developing countries analyzed above, the average R&D investment as a percentage of GDP decreased between the mid seventies and the nineties (graph 4) after trade reforms.

Our assumption of sector heterogeneity address sector differences concerning the way that labor productivity reacts to technology embodied in imported capital equipment. By stressing this heterogeneity we want to capture the idea that improving labor productivity through the accumulation of capital equipment differs, for instance, in the woods production and electronic devices sectors. However, it is difficult to find data of imported capital equipment by sector. If some calculation can be made in order to get capital stock, it still remains at a national level, so the variance is already determined by the country specialization. Having this in mind we still can illustrate this assumption with some available data assuming, as a consensual fact, the idea that only more productive firms export. We use the Survey on Technological Behavior of Industrial Argentinean Firms ("Encuesta sobre la conducta tecnologica de las empresas industriales argentinas") for 1639 firms that covers the period 1992-1996.³

¹Basic goods are natural resources, animal and animal products, vegetable products, food and beverages, mineral products, plastics and rubber, wood, articles of stone, precious or semi-precious stones, textiles. Industrialized goods are chemical products, machinery, mechanical appliances, electrical equipment, vehicles, transportation equipment, instruments - measuring, arms and ammunition.

²In this study we do not take into account the Asian countries such as Korea, Singapore, Thailand, the Philippines and Malaysia that have experienced a process of industrialization during the nineties and consequently, the share of industrialized goods exported increased significantly during this period.

³This survey was conducted by the National Institute of Census and Statistics of Argentina, INDEC. This sample of firms represents 54% of industrial sales, 50% of employment and 61%

We aggregate firms' data into two digits sectors and define export sectors as those that have more than 15% of exports over total sales. Graph 5 shows that export sectors in 1996 are those that mostly accumulated imported technology between 1992 and 1996 (measured as the variation of investment in imported capital equipment over total labor). Furthermore, new exporters in 1996 are those non-export sectors in 1992 that mostly accumulated imported technology in the period. Finally, we can also observe that the main export sectors are basic industrial goods related to natural resources such as leather, basic metals, food and beverages, and woods.

In order to formalize our argument we construct an inter-industry model, extending the work of Melitz (2003). Trade policy is represented by both iceberg costs (tariffs) and fixed export costs, which are not only regulation costs or non tariffs barriers, but also costs of adapting products to the new foreign market. In each industry there is a firm that monopolistically produces a different good. Three main assumptions are imposed, closely related to each other. First, labor productivity gains are endogenously determined by investment in technology. Second, this technology is embodied in imported capital goods and then its price depends on tariffs. Third, heterogeneity among sectors determines the effect of imported capital equipment on labor productivity.

Based on these assumptions, we explain two channels through which trade policy impacts the composition of the export basket. The first one is the standard effect of a reduction of tariffs that increases export profits by raising foreign demand and increasing the varieties exported. The second channel is based on changes in the price of imported capital equipment. The impact of these price changes on sectors depends on the reaction of labor productivity to the new technology. If there is a decrease in tariffs that reduces the price of imported capital goods, then the industries that are mostly benefited, in terms of productivity gains, from imported technology, will be the ones that will mostly increase their profitability.

This second channel is the main contribution of our model. It alters the standard effect of export diversification induced by trade liberalization. One of the new results is that the process of trade liberalization is biased towards sectors where imported investments have a higher impact on labor productivity. Moreover, this feature suggests another interesting result concerning trade policy: it can be argued that trade liberalization would have little impact on export qualitative diversification in countries already highly open.

The rest of the paper is organized as follows. In Section 2 the set-up of the model is presented. Section 3 develops the main results. Section 4 concludes.

of exports in 1996.

2 The model

Sector export specialization cannot be explained without introducing sector heterogeneity. Constructing a model with two different sectors with different productivity levels would not allow us to address the question about the types of goods exported. Do all sectors benefit in the same way from trade liberalization? Or, conversely, does the impact of trade on specialization depend on technological differences across sectors? In order to answer these questions, our argument is based on the international economics literature about firm's heterogeneity, such as Hopenhayn (1992), Melitz (2003), Ghironi and Melitz (2004) and Bergin et al. (2005) and Corsetti et al. (2005), among others.

Melitz (2003) develops an intra-industry model to analyze the impact of trade liberalization in a framework with heterogeneous firms that differ in their productivity levels. His model shows that exposure to trade will induce two selection processes that will favor the more productive firms. First, only more productive firms will be able to enter the export market, as exporting is costly due to the existence of both variable and fixed export costs. Second, assuming also the existence of fixed cost in production, exposure to trade will force less productive firms to exit the domestic market. This second type of selection is explained ex-post through a mechanism of competition for the labor factor. Actually, trade liberalization enhances (foreign) demand. To satisfy this demand, an increase of factor demand (labor) occurs, that in turns rises real wages. This increase of marginal costs forces the least productive firms to exit the domestic market, since they will also be un-able to face the fixed cost of production. By this two selection channels trade liberalization leads to a reallocation towards more productive firms, increasing the average productivity of a country.

This literature, also called the "new new trade theory", has pointed out several reinterpretations of the Balassa Samuelson (BS) effect. Ghironi and Melitz (2004) analyze three channels of real exchange rate appreciation, which depend on the incorporation of endogenous entry and on reallocation of market share to more productive firms. The main conclusion is that deregulation of the products market (as well as the effects of a permanent increase in home productivity), leads to an appreciation of home labor. Consequently, real exchange rate appreciates and the number of export firms decreases. Bergin et al. (2005) also develop an updated BS model to explain the presence of productivity differences between traded and non traded sectors. They consider monopolistic competition, fixed export costs and heterogeneous productivity across firms. In their paper, tradability is endogenously determined by productivity gains which are in turn modelled as exogenous shocks. Differently from Ghironi and Melitz (2004), they consider a fixed number of firms since they focus on heterogeneity across industries. They use data for U.S at 2, 3 and 4 digit industry level to show differences on productivity levels across industries.

Corsetti et al. (2005) focus on the international spillovers related to two types of different productivity gains. First, gains that enhance manufacturing efficiency; second, gains that lower the firm's entry cost and product differentia-

tion. They study the effects of productivity variations on relative prices, the real exchange rate and welfare. Each type of productivity has different implications for the equilibrium allocation.

However, these models do not address the question of productivity gains biased towards some sectors that become traded afterwards. Therefore, they do not analyze export specialization in a qualitative way. To answer this question we construct an inter-industry model based on the framework of Melitz (2003). We suppose an initial investment in technology embodied in imported capital equipment. This investment is a firm's choice that crucially depends on the heterogeneous impact of technology on labour productivity. It could be interpreted as an endogenous fixed production cost that is amortized and paid each period. Consequently, in our model, sector labor productivity is endogenously determined by the level of investment in imported technology. The biased effect of trade comes from the heterogeneous incitation to capital purchasing after a decrease in capital prices driven by a reduction of tariffs. Finally, as we are interested in sector export specialization we neglect Melitz' firms' entry framework and we assume a fixed number of firms, each one identifying an industrial sector. Although the selection and resources reallocation mechanism highlighted by Melitz is absent in our model, there is a shift in average productivity levels induced by trade reform through the investment channel.

2.1 Households Consumption

There are two symmetric countries home (h) and foreign (f), that represent two small open economies. The representative household allocates consumption between home and foreign goods. Home goods can be traded or non-traded depending on the firm's profitability. Consumer's preferences are represented by standard C.E.S. utility function C between home and foreign goods. All variables with an asterisk (*) represent the foreign market.

$$C = \left(\int_0^1 C_{hi}^{\frac{\phi-1}{\phi}} di + \int_{\alpha_{f*}}^1 C_{fi}^{\frac{\phi-1}{\phi}} di \right)^{\frac{\phi}{\phi-1}} \quad (1)$$

The elasticity of substitution between home and foreign goods is the same in both countries.

The optimal inverse demand functions are:

$$C_{hi} = \left(\frac{P}{p_{hi}} \right)^{\phi} C \quad (2)$$

$$C_{fi} = \left(\frac{P}{p_{fi}^* (1+\tau)e} \right)^{\phi} C \quad (3)$$

Goods produced in each country represent different industries that belong to a continuum support of size 1. Among them, a proportion $1 - \alpha^*$ are able to export to the foreign market. The home price index that corresponds with the C.E.S. consumption function is given by:

$$P = \left[\int_0^1 (p_{hi})^{1-\phi} di + \int_{\alpha_{f*}}^1 (p_{fi}^* (1+\tau)e)^{1-\phi} di \right]^{\frac{1}{1-\phi}} \quad (4)$$

Where e is the nominal exchange rate quoted as home currency relative to foreign one.

2.2 Firms

In each sector, there is one firm that produces a different good. As in Melitz (2003) the representative firm produces with a constant returns production function of labor, which is inelastically supplied in perfect competition.

$$Y_{hi} = A_{hi} l_{hi} \quad (5)$$

Labor productivity (A_{hi}) depends on the initial investment in imported technology. We assume that all capital goods are imported and supplied to both countries by the rest of the world in perfect competition. Thus, imported capital goods will not affect the trade balance condition between the two small open economies.

$$A_{hi} = \alpha_{hi} I_{hi0} \quad (6)$$

Technology, embodied in imported capital goods, will have a different impact on labor productivity in each sector depending on α_{hi} . Heterogeneity among sectors is defined by α_{hi} , which represents the marginal effect of imported capital technology on labor productivity. A high value of α_{hi} implies that the nature of the sector production function allows a more significant increase in labor productivity through purchasing imported capital technology.

Equation (6) implies a capital imported equipment elasticity of productivity equal to one, in spite of heterogeneity. If initial investment is exogenous and is the same for all sectors, the effect of capital goods on productivity would be homogeneous. In this model, the firm's investment (I_{hi0}) is a decision and will be endogenously determined by α_{hi} . Since α_{hi} differs among sectors, not only investment but also labor productivity will be heterogeneous.

Investment is made once: at the beginning of the firm's life and before it enters to the market. During production, firms behave as if they have constant returns on labor with a given level of productivity. Hence, first order conditions of monopolistic firms means that prices remain a mark-up over the marginal cost.

$$p_{hi} = \frac{\phi}{\phi-1} \frac{W_{hi}}{A_{hi}} \quad (7)$$

Symmetrically, the price of home goods sold in the foreign market is higher due to tariffs.

$$p_{hi}^* = \frac{\phi}{\phi-1} \frac{W_{hi}}{A_{hi}} \frac{(1+\tau)}{e} \quad (8)$$

Revenues of the firm of each sector can be divided into revenues earned by domestic sales (r_{dhi}) and revenues from export sales (r_{xhi}).

$$r_{dhi} = \left(\frac{P}{p_{hi}} \right)^{\phi-1} R$$

Where R is the aggregate revenue of the country ($PC = R$).

Revenues earned by export sales are given by:

$$r_{xhi} = r_{dhi} (1 + \tau)^{1-\phi}$$

Total revenue "r_{hi}" of an industry depends on its export status:

$$r_{hi} = r_{dhi} \quad \text{if the industry does not export}$$

$$r_{hi} = r_{dhi} + r_{xhi} = r_{dhi} \left[1 + (1 + \tau)^{1-\phi} \right] \quad \text{if the industry exports}$$

Similarly, profits are divided into profits earned from domestic sales (π_{dhi}) and those earned from export sales (π_{xhi}):

$$\pi_{dhi} = \frac{r_{dhi}}{\phi} - \delta (1 + \tau) I_{hi0}$$

$$\pi_{xhi} = \frac{r_{xhi}}{\phi} - f_x = \frac{r_{dhi}}{\phi} (1 + \tau)^{1-\phi} - f_x$$

Sectors that have a higher labor productivity, which depends on the initial technology investment and on the way that this investment affects productivity (α_{hi}), will charge a lower price, have a higher demand and earn higher profits than less productive sectors. Similar results hold for the foreign country.

2.3 Firm's value and initial investment

The decision schedule can be resumed as follow. In $t = 0$ firms have to decide their capital technological investment. From $t = 1$ to $t = \infty$ they produce with their initial capital endowment which remains unchanged. Therefore, using a backward induction logic, they set optimal prices taking I_{hi0} as given (eq. 7 and 8) and then they decide the value of I_{hi0} that maximizes their escompted net optimized profits, which represents the value of firms $v_t(A_{hi})$.

We assume that neither country is larger enough to alter the world price of capital equipment. For this reason, we equal this price to unity and we will focus only on the effect of tariffs.

$$v_t(A_{hi}) = \frac{1}{\delta} \frac{r_{dhi}}{\phi} \left[1 + (1 + \tau)^{1-\phi} \right] - I_{i0} (1 + \tau)$$

$$\frac{\partial v(A_{hi})}{\partial I_{hi0}} = 0$$

$$I_{hi0} = \xi (P\alpha_{hi})^{\frac{\phi-1}{2-\phi}} \equiv I(\alpha_{hi}) \quad (9)$$

$$\xi \equiv \left[\frac{R \left(\frac{\phi-1}{\phi} \right)^\phi [(1+\tau)^{1-\phi} + 1]}{\delta(1+\tau)} \right]^{\frac{1}{2-\phi}}$$

To highlight a behaviour where α_{hi} has a positive impact on investment we need to restrict the constant elasticity of substitution to $1 < \phi < 2$. As firms represent sectors this assumption of weak substitutability is not unrealistic. Essentially, the impact of α_{hi} on investment can be divided into two opposite effects: a revenue and a substitution effect. On the one hand, the revenue effect means that a higher value of α_{hi} implies less investment to obtain a given degree of productivity. On the other hand, the substitution effect means that a higher value of α_{hi} enhances the productivity level leading to a higher substitution between capital and labor, increasing investment. Between these effects we want to focus on the latter.

2.4 Aggregation

In order to analyze the impact of investment on labor productivity in an open economy model, we follow Melitz (2003) in assuming symmetry across countries. This assumption ensures equal wages rates (that will be normalized $W = 1, W^* = \frac{1}{e}$) as well as the equalization of prices ($eP^* = P$). Hereafter we drop country notations.

Heterogeneity (α_i) is represented by a distribution function $g(\alpha_i)$. Note that there is no uncertainty in the model. Each firm knows the value of its α_i . However it still remains a variable in a population with a specific distribution function. Then we can still obtain aggregate variables using average calculations. For tractability reasons we assume that $g(\alpha_i)$ is a uniform distribution function over (0,1). Hence:

$$g(\alpha_i) = 1 \quad 0 \leq \alpha_i \leq 1$$

$$G(\alpha_i) = \alpha_i$$

The accumulated distribution function $G(\alpha^*) = \alpha^*$ is the probability that α takes a value lower than α^* . This value (α^*) is the export cutoff of the marginal effect of capital goods on labor productivity. As productivity increases with α , this export cutoff corresponds to the minimum level of α_i that makes export profits equals to zero. Therefore, $1 - G(\alpha^*) = 1 - \alpha^*$ is the proportion of exporting firms.

Index price, assuming symmetric countries and after applying trade balance condition, is given by the following expression:

$$P = \left[\int_0^1 (p_i)^{1-\phi} di + \int_{\alpha^*}^1 (p_i (1 + \tau))^{1-\phi} di \right]^{\frac{1}{1-\phi}} = P^* e$$

Trade balance accounting for each country concerns two components: consumption goods and capital. The former is the standard export-import balance

accounting between the two countries and the latter is the amortization of initial capital importation from the rest of the world, which is paid by revenues coming from sales. Since both components are supplied and paid independently their accounting can also be done independently. Thus, trade balance condition between both countries considers only consumption goods. Using our assumption of symmetry and the standard results of CES demand formulation, one can get directly the above expression of index price.⁴

Although our assumption regarding $g(\alpha_i)$ implies that to each sector i corresponds a specific α_i , in order to clarify the presentation we continue to distinguish between both supports. This means that $(p_i)^{1-\phi}$ is defined by an aleatory variable α_i , from which we obtain the following average prices:

$$P = \left[\int_0^1 \int_0^1 \left(\frac{\phi}{\phi-1} \frac{1}{A_i} \right)^{1-\phi} g(\alpha_i) d\alpha_i di + \int_{\alpha^*}^1 \frac{1}{(1-\alpha^*)} \int_{\alpha^*}^1 \left(\frac{\phi}{\phi-1} \frac{1}{A_i} (1+\tau) \right)^{1-\phi} g(\alpha_i) d\alpha_i di \right]^{\frac{1}{1-\phi}}$$

$$P = \frac{\phi}{\phi-1} \left[\int_0^1 (A_i)^{\phi-1} g(\alpha_i) d\alpha_i + (1+\tau)^{1-\phi} (1-\alpha^*) \frac{1}{(1-\alpha^*)} \int_{\alpha^*}^1 (A_i)^{\phi-1} g(\alpha_i) d\alpha_i \right]^{\frac{1}{1-\phi}}$$

Regarding exports, average productivity is calculated conditional to entry into the respective market. The probability distribution of α_i for export sectors, conditional on entering the export market, is $\frac{g(\alpha_i)}{(1-\alpha^*)}$.

Following Melitz (2003) we define aggregate productivities as weighted averages:

$$\left(\widetilde{A}_d \right)^{\phi-1} \equiv \int_0^1 (A_i)^{\phi-1} g(\alpha_i) d\alpha_i = \int_0^1 (\alpha_i I_{i0})^{\phi-1} g(\alpha_i) d\alpha_i \quad (10)$$

$$\left(\widetilde{A}_x \right)^{\phi-1} \equiv \frac{1}{(1-\alpha^*)} \int_{\alpha^*}^1 (A_i)^{\phi-1} g(\alpha_i) d\alpha_i = \frac{1}{(1-\alpha^*)} \int_{\alpha^*}^1 (\alpha_i I_{i0})^{\phi-1} g(\alpha_i) d\alpha_i \quad (11)$$

$$\widetilde{A}_T^{\phi-1} \equiv \left[\widetilde{A}_d^{\phi-1} + (1-\alpha^*) (1+\tau)^{1-\phi} \widetilde{A}_x^{\phi-1} \right] \quad (12)$$

⁴Formally, trade balance considering aggregated baskets of home (H) and foreign (F) export goods, implies $P_{HT}^* C_{HT}^* = P_{FT} C_{FT}$, where $C_{FT} \equiv \left(\int_{\alpha_f^*}^1 C_{fi}^* \frac{\phi-1}{\phi} di \right)^{\frac{\phi}{\phi-1}}$; $C_{HT}^* \equiv$

$$\left(\int_{\alpha^*}^1 C_{hi}^* \frac{\phi-1}{\phi} di \right)^{\frac{\phi}{\phi-1}} ; P_{FT} = \left(\int_{\alpha_f^*}^1 (p_{fi}^* (1+\tau) e)^{1-\phi} di \right)^{\frac{1}{1-\phi}} ; P_{HT}^* = \left(\int_{nt^*}^{N^*} (p_{hi} \frac{(1+\tau)}{e})^{1-\phi} di \right)^{\frac{1}{1-\phi}}$$

$$P = \frac{\phi}{\phi-1} \frac{1}{\widetilde{A_T}} \quad (13)$$

As in Melitz (2003) the aggregate price can be resumed by the global average productivity $\widetilde{A_T}$, but in this model this productivity depends on investment decisions. Since investment depends on global prices, so do domestic and export average productivities.

$$\widetilde{A_d}^{\phi-1} = \left(\xi P^{\frac{\phi-1}{2-\phi}} \right)^{\phi-1} \int_0^1 (\alpha_i)^{\frac{\phi-1}{2-\phi}} g(\alpha_i) d\alpha_i$$

$$\widetilde{A_x}^{\phi-1} = \left(\xi P^{\frac{\phi-1}{2-\phi}} \right)^{\phi-1} \frac{1}{(1-\alpha^*)} \int_{\alpha^*}^1 (\alpha_i)^{\frac{\phi-1}{2-\phi}} g(\alpha_i) d\alpha_i$$

This circular relationship defines $\widetilde{A_T}$ as follow:

$$\widetilde{A_T} = \kappa \widehat{\alpha} \quad (14)$$

where

$$\kappa \equiv \xi^{2-\phi} \left[\frac{\phi}{\phi-1} \right]^{\phi-1}$$

$$\widehat{\alpha} \equiv \left[(\widehat{\alpha_d})^{\frac{\phi-1}{2-\phi}} + (1+\tau)^{1-\phi} (1-\alpha^*) (\widehat{\alpha_x})^{\frac{\phi-1}{2-\phi}} \right]^{\frac{2-\phi}{\phi-1}}$$

$$(\widehat{\alpha_d})^{\frac{\phi-1}{2-\phi}} \equiv \int_0^1 (\alpha_i)^{\frac{\phi-1}{2-\phi}} g(\alpha_i) d\alpha_i$$

$$(\widehat{\alpha_x})^{\frac{\phi-1}{2-\phi}} \equiv \frac{1}{1-\alpha^*} \int_{\alpha^*}^1 (\alpha_i)^{\frac{\phi-1}{2-\phi}} g(\alpha_i) d\alpha_i$$

Where $\widehat{\alpha}$ is the average of α_i that ag-

gregates heterogeneity taking into account the opposite effects of α_i explained above. As we focus on a substitution effect between capital and labor ($1 < \phi < 2$) a decrease in the cutoff level (α^*) has a positive impact on total average productivity. Similarly, $\widehat{\alpha_d}$ and $\widehat{\alpha_x}$ are the domestic and export counterparts of $\widehat{\alpha}$.

Note that after putting average productivity in investment, we can derive the firm's productivity as a function of α_i and its ratio over $\widehat{\alpha}$.

$$A_i = \alpha_i I(\alpha_i) = \alpha_i \kappa \left[\frac{\alpha_i}{\widehat{\alpha}} \right]^{\frac{\phi-1}{2-\phi}} \equiv A(\alpha_i)$$

So at equilibrium average productivity can be resumed as the productivity of a representative firm. In this representative firm the impact of capital on labor productivity is $\alpha_i = \hat{\alpha}$. Hence $A_T = A(\hat{\alpha}) = \kappa\hat{\alpha}$

Assuming that $g(\alpha_i)$ is a uniform standard distribution, we obtain $\hat{\alpha}$ as a function of the cutoff level, tariffs and ϕ :

$$\hat{\alpha} = \left[\frac{1+(1+\tau)^{1-\phi} \left(1-(\alpha^*)^{\frac{1}{2-\phi}} \right)}{(2-\phi)} \right]^{\frac{2-\phi}{\phi-1}}$$

Global accounting gives the relationship between global variables and determines the labor market clearing condition. Differently from Melitz (2003), aggregate revenue (R) is determined by total labor income (WL) and total non-zero profits (Π).

$$R \equiv \int_0^1 r_i di = PC = L + \Pi \tag{15}$$

Total labor is exogenously fixed and the aggregate profit is determined by the total revenue, the amortized value of domestic investment and the fixed export cost. One can easily show that domestic investment is equal to the investment of a representative domestic firm with $\alpha_i = \hat{\alpha}_d$. Recall that investment function depends also on the global average $\hat{\alpha}$.

$$\Pi = \frac{R}{\phi} - \delta(1+\tau)I(\hat{\alpha}_d) - f_x$$

2.5 Tradability condition

Tradability condition implies that only those firms with operating profits that counterweigh the fixed export costs will be able to export. On account of demand effects the lower the price, the higher the profit. We can expect an export specialization process in those sectors where import technology has a higher impact on labor productivity.

The zero cutoff profit condition to enter the export market is given by:

$$\begin{aligned} \pi_x(\alpha^*) &= 0 \\ \frac{r_{di}(\alpha^*)}{\phi} (1+\tau)^{1-\phi} &= f_x \end{aligned} \tag{16}$$

From this condition we can derive the value of the cutoff α^* which determines the average variables. These variables in turns affect the firm's decisions and, consequently, the equilibrium value of the cutoff.

3 Results: determination of the equilibrium

In the steady state, the equilibrium level of export cutoff α^* is determined by aggregate productivity, global accounting and the tradability condition. Thus, from (14), (15) and (16) we calculate α^* in general equilibrium. The zero cutoff profit condition to enter the export market implies:

$$2[\alpha^*]^{\frac{1-\phi}{2-\phi}} \left[1 + (1 + \tau)^{(\phi-1)} \right] - \alpha^* - \left(\frac{2-\phi}{\phi-1} \right) \gamma = 0 \quad (17)$$

where $\gamma \equiv \left(\frac{L-f_x}{f_x} \right)$ is the fixed ratio of labor allocated to production and labor allocated to cover fixed export costs. Without loss of generality for $1 < \phi < 2$, and for tractability reasons we set $\phi = 1,5$ and solve for α^* . We show in the appendix 2 that a unique solution exists and it presents the following properties:

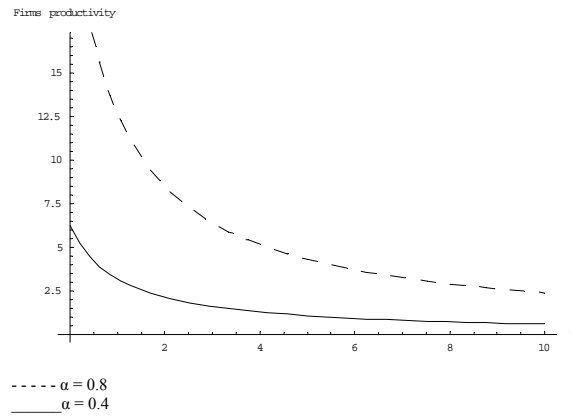
$$\frac{\partial \alpha^*}{\partial \tau} > 0 \quad (18)$$

$$\eta \equiv \frac{\partial \alpha^*}{\partial \tau} \frac{\tau}{\alpha^*} = f(\tau) > 0 \quad (19)$$

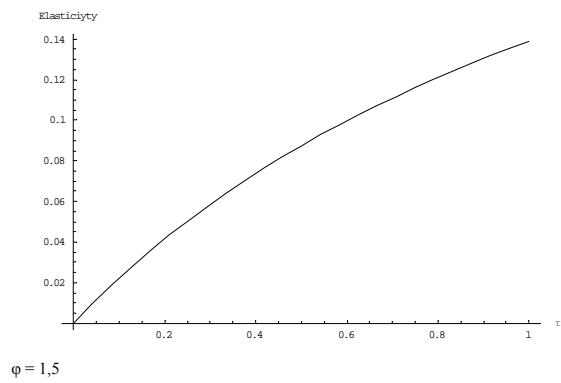
Thus α^* and its tariffs elasticity η are positive and increasing functions of tariffs. The effect of trade liberalization can be separated in two channels whether one observes the demand or supply consequences of tariffs. On the one hand, since productivity increases with α_i , in (18) we can observe the standard channel through which a reduction of tariffs will decrease the export cutoff productivity level, allowing more firms to acquire export status. The reduction of tariffs leads to a decrease of export price and to an increase of foreign demand, which in turns increases export profits. In this new equilibrium firms need a lower level of productivity to pay the fixed export costs and to sell in the foreign market.

On the other hand, the model introduces another channel in which trade liberalization is biased towards sectors where capital has a greater impact on labor productivity. Actually, we observe in (18) that, among non exporters, those sectors with higher α_i will become new exporters. This is not a linear transformation of Melitz (2003) heterogeneous productivity. The increase on export profits induced by the reduction of tariffs will be greater for sectors where investment in technology leads to a higher increase of labor productivity. Differently from Melitz (2003), labor productivity is determined endogenously by capital imported investment. Consequently firm's productivity gains depend on tariffs. A reduction of tariffs affects differently firm's decisions depending on α_i . Sectors where imported capital equipment has a higher impact on labor productivity will become more productive after trade liberalization, regardless the reduction of the cutoff productivity level explained above.

Graph 1: "The heterogeneous impact of a reduction of tariffs on firm's labor productivity"



Graph 2: "Tariffs elasticity of α^* cutoff"



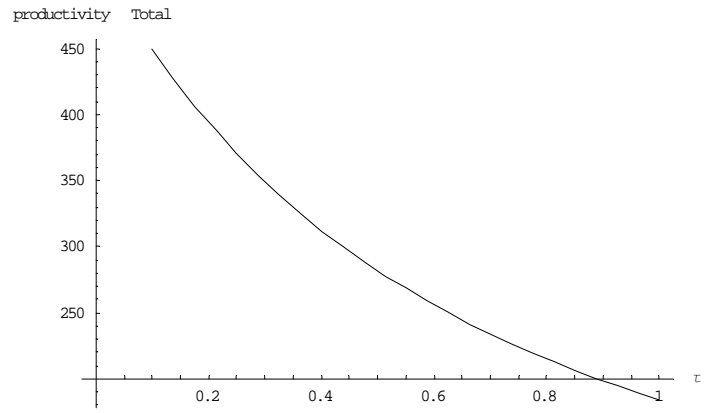
$\phi = 1,5$

We can observe this result from our simulations. We measured the impact of a reduction of tariffs on individual labor productivity for high and low values of α_i (0.8 and 0.4, respectively). Graph 1 shows that in both cases a reduction of tariffs increases labor productivity, but this increase depends on α_i . The higher the α_i parameter, the higher the increase in productivity after a reduction of tariffs, since there is a shift in the slope of the curve.

The model suggests an interesting result concerning trade policy. According to tariffs elasticity of cutoff (19) developed in the appendix 2, the form of $f(\tau)$ implies that a reduction of tariffs has a little impact on the reduction of the cutoff level. Moreover, this effect depends on the level of tariffs. Our simulations show that the tariffs elasticity of α^* remains between 0,02 and 0,07 for levels of tariffs between 20% and 40% (see Graph 2). Therefore, if the level of the tariff is already low, a reduction will have almost no impact on export diversification towards sectors where capital equipment is less substitute of labor. These results are robust in the sense that they remain unchanged for a very wide interval of γ , which is an inverse measure of fixed export cost relative to total labor costs.

Finally, as we do not consider firm entry-exit processes the model does not have the reallocation process of Melitz (2003). Nevertheless, the average productivity level shifts up-wards since this depends on initial investment, which in turns depends on tariffs (Graph 3). A reduction of variable trade costs will have two effects on aggregate productivity. Firstly, there will be an increase in the total investment of the economy as the price of imported technology depends on tariffs. Secondly, a reduction of tariffs decreases the alfa export cutoff level adding more productivity to the global average. In Graph 9 we can observe the impact of a reduction of tariffs on the average productivity level.

Graph 3: “The impact of trade reform on the average productivity of the country”



$\phi = 1.5$

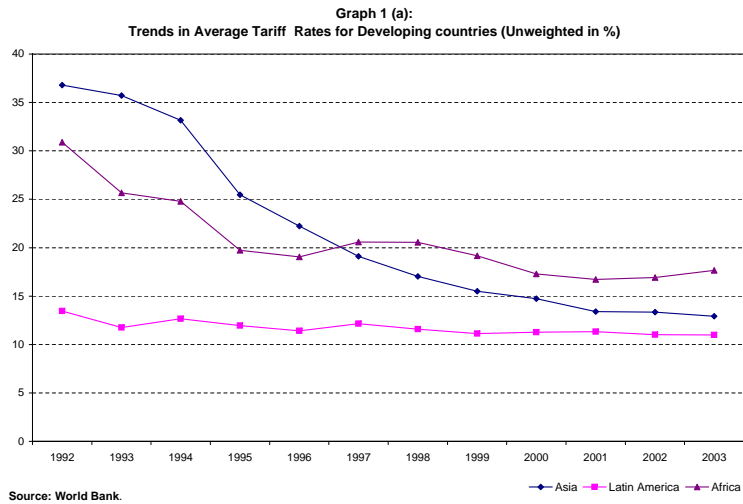
4 Conclusions

This study sheds light on the effects of globalization on the pattern of export specialization in countries highly dependant on imported technology. The main contribution of this paper is to analyze endogenous productivity gains determined by investment in imported capital goods, extending the framework of Melitz (2003). The incorporation of endogenous productivity gains allows to explain the composition of export basket after trade liberalization.

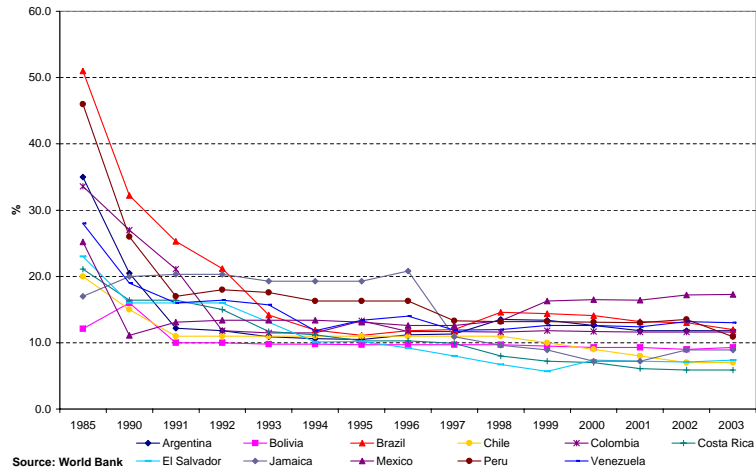
The model proposed in this paper introduces two main results. Firstly, trade liberalization can induce a profitability bias towards sectors where productivity can be easily improved by imported capital investment. Secondly, contrary to the standard vision that supports the idea of a reduction of tariffs to reach export diversification, this work argues that, in the case of a country that has already a high degree of openness to international trade, a reduction of tariffs will have almost no impact on export diversification.

After trade liberalization, in most Latin-American and some Asia's countries the pattern of export specialization in basic goods persists. The experience of these countries illustrates the model's features. Sectors producing basic goods are commonly viewed as having a relatively large endowment of un-skilled labor. Capital is supposed to be a better substitute of unskilled labor than of skilled labor. Therefore, in these countries sectors producing basic goods have received more benefits from the reduction of the price of imported capital equipment. From our point of view, further research should be oriented to give empirical support to these arguments, namely concerning sector heterogeneity.

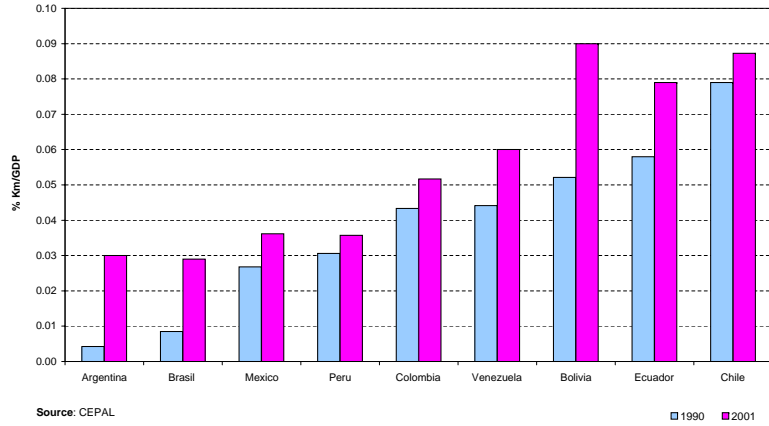
5 Appendix 1



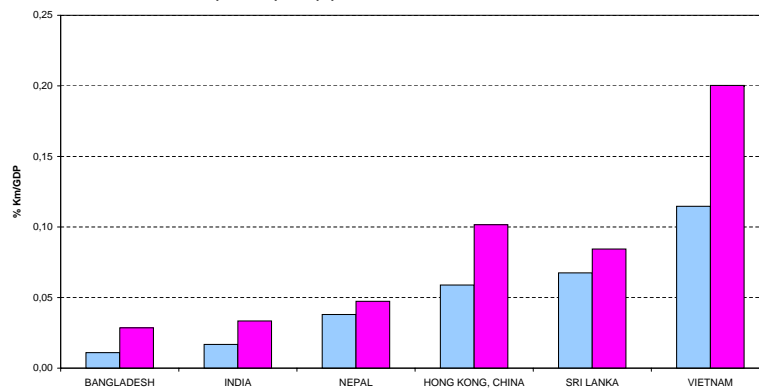
**Graph 1 (b):
Trends in Average Tariff Rates for Latin America's Countries, 1985-2003**



**Graph 2 (a):
Imported capital equipment over GDP in Latin America**



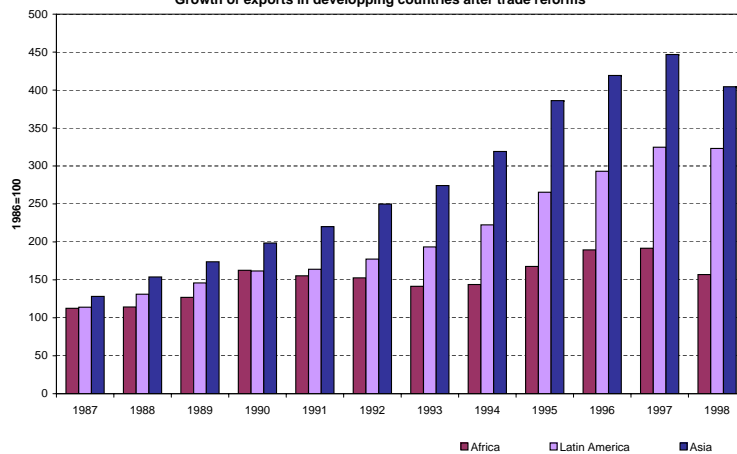
**Graph 2 (b):
Imported capital equipment over GDP in some Asian countries**



Source: Asian Development Bank (ADB)

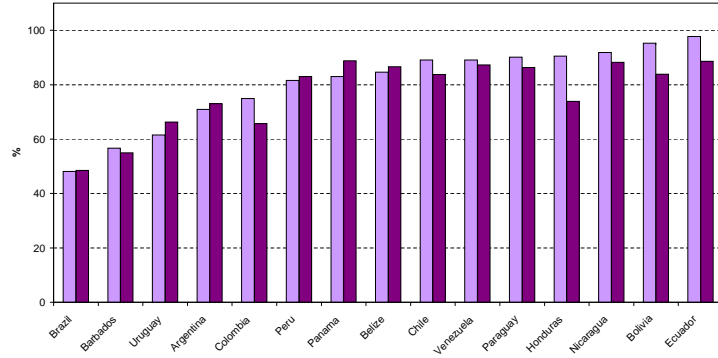
1990 2003

**Graph 3 (a):
Growth of exports in developing countries after trade reforms**



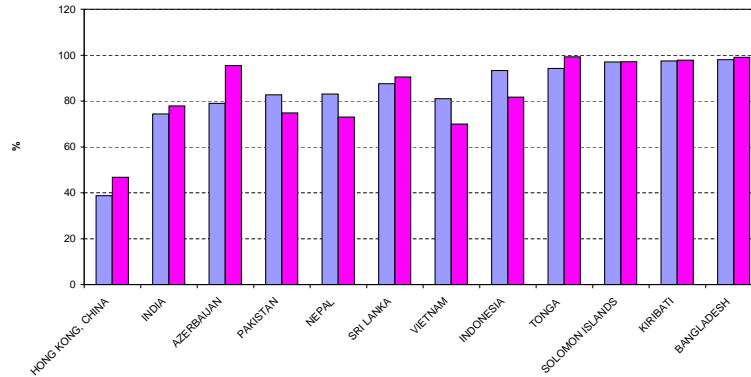
Source: Global Development Finance & World Development Indicators, WB.

Graph 3 (b):
Share of basic goods exports in Latin America



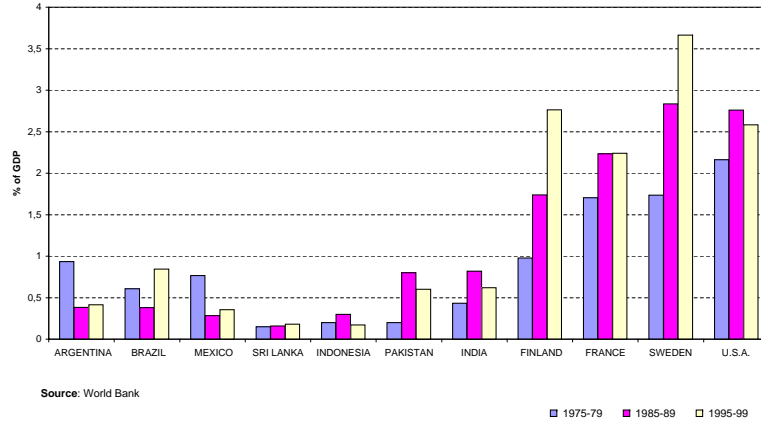
Source: CEPAL.
Basic goods: Natural resources, Animal and animal products, Vegetable products, food and beverages, Mineral products, Plastics and rubber, Wood, Articles of stone, precious or semi-precious stones, textiles.

Graph 3.c.:
Share of basic goods exports in some Asian countries

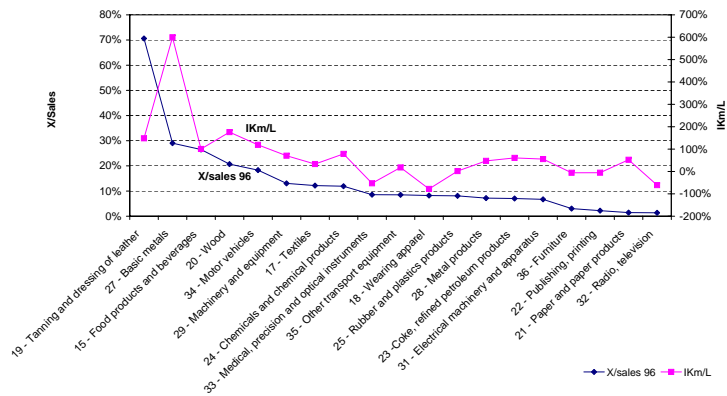


Source: Asian Development Bank (ADB).
Basic goods: Natural resources, Animal and animal products, Vegetable products, food and beverages, Mineral products, Plastics and rubber, Wood, Articles of stone, precious or semi-precious stones, textiles.

Graph 4:
R&D Investment as a percentage of GDP in Developing and Industrialized countries



Graph 5:
Export status and investment in imported capital goods in Argentina in 1996



6 Appendix 2

For $\phi = 1, 5$ tradability condition becomes:

$$(\alpha^*)^2 + \alpha^* \gamma - 2 \left[1 + \sqrt{(1 + \tau)} \right] = 0$$

The feasible solution of the cut-off

$$\alpha^* = \frac{-\gamma + \sqrt{\gamma^2 + 8 \left[1 + \sqrt{(1 + \tau)} \right]}}{2}$$

The effect of tariffs on cut-off solution is given by:

$$\frac{\partial \alpha^*}{\partial \tau} = \frac{1}{\sqrt{\gamma^2 + 8 \left[1 + \sqrt{(1 + \tau)} \right]} \sqrt{(1 + \tau)}} > 0$$

The tariffs elasticity of cu-off solution is given by:

$$\eta \equiv \frac{\partial \alpha^*}{\partial \tau} \frac{\tau}{\alpha^*} = \frac{1}{\sqrt{\gamma^2 + 8 \left[1 + \sqrt{(1 + \tau)} \right]} \sqrt{(1 + \tau)}} \frac{2\tau}{\left(-\gamma + \sqrt{\gamma^2 + 8 \left[1 + \sqrt{(1 + \tau)} \right]} \right)} \equiv f(\tau) > 0$$

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