PRODUCTIVITY AND TRADE OPENNESS: MICRO-LEVEL EVIDENCE FROM MANUFACTURING INDUSTRIES IN ECUADOR 1997– 2003

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Abstract

This study is part of a growing branch of the empirical economic literature that tries to examine the effects on productivity of countries that have opened their markets to global competition. This study takes a detailed empirical look at whether Ecuador's trade liberalization has increased or decreased the productivity of Ecuadorian manufacturing establishments for the period 1997-2003. The research focuses on both own establishment productivity changes and the reshuffling of resources from less to more productive units. It applies robust estimation procedures on micro-level data to identify the effect of trade policy on productivity, controlling for a number of other economic events that may have affected productivity during the period under study. The study takes a particular interest in how both exporters and import-competing sectors respond to trade openness. Preliminary results suggest that aggregate productivity has increased in some manufacturing sectors at the end of the period, such as in food processing, apparel and leather, and furniture. Increased aggregate productivity might be due to both more output being produced by more productive establishments and slightly increased own-plant's productivity.

The results suggest evidence of a positive and significant effect of trade openness on the productivity of manufacturing industries in export-oriented industries in the years after trade reforms were implemented, but decreasing productivity after 2000.

Keywords: productivity, trade openness, micro-level data, Ecuador.
JEL codes: F10, O10

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1. Introduction

In the early and mid 1990s Ecuador made important changes in trade policy, aimed at reducing trade barriers and fostering export activities. This was in striking contrast to trade policies followed in the 1960s and 1970s, when Ecuador followed the policy of import substitution which, given its failure to promote sustainable growth and employment, fell prey to growing criticism in the 1980s. One of the Ecuadorian governments' main reasons for pursuing this trade-oriented policy was to foster growth and productivity (Tamayo 1997, Comexi 2004).

These changes in trade policies included a tariff reform, important reductions in import restrictions, export promotion laws, the modernization of trade institutions, and the simplification of trade procedures. For instance, tariff reform brought tariff rates down from a range of 29-290 percent in 1989 to a range of 0-40 percent (the upper level applying to vehicles) in 1994. The average nominal tariff rate was reduced from 29 percent in 1989 to 11.3 percent in 1996.[1]

This one aspect of increased trade openness –a tariff reform designed to lower tariffs, reduce their dispersion, and simplify their application– brought about changes in import patterns that had significant impact on the Ecuadorian manufacturing industry. Imports of capital goods for industry and agriculture grew 24 percent between 1993 and 1996, and 22 percent from 1997 to 2003. Imports of consumption goods also experienced considerable growth during the period of tariff reform, increasing 58 percent between 1993 and 1996, and 80 percent from 1997 to 2003.

These trade liberalization policies set up in Ecuador were expected to have a positive impact on productivity. Trade theory actually points to various channels through which trade liberalization can affect productivity, although there is no clear-cut answer as to whether the effect on productivity should be always positive, or as to whether there should be a clear cause-effect relationship between trade policy and productivity (either in levels or in growth rates). These channels include access to better and cheaper technology, economies of scale, and spillover effects. Firms that work in an open economy can have exposure to foreign technology and may learn about the newest and best production

[1] For a study on the Ecuadorian tariff evolution and reforms, see Tamayo (1997).

techniques. Firms that export their production have access to other, probably bigger markets which may allow these firms to produce at a more efficient scale with the typical move down their average cost curves. But import competing firms may face the entry of foreign firms that may reduce their market share and/or force import competing firms to produce on a lower, less efficient scale. International trade exposure may bring positive spillovers to domestic firms as foreign firms bring more efficient managerial skills, on-the-job-training programs, increased competence, etc.

Whether trade liberalization in Ecuador has indeed had an impact on productivity is an empirical question that needs to be addressed. The present study analyzes survey data from the Ecuadorian manufacturing industry for the period 1997-2003 to estimate correlations between trade openness and productivity and determine how manufacturing productivity evolves in the sample after trade liberalization policies have been in place. The study focuses on the estimation of productivity gains resulting from own productivity improvements and the reshuffling of resources from less to more productive establishments. Ecuador also presents a rather unique case for this type of study because it is necessary to empirically separate any productivity effects of the economy's recent dollarization and economic shocks from the effects of trade openness. This empirical analysis tries to account for establishments' heterogeneity and control for simultaneity bias.

In a production process, firms' managers know their own productivity. Based on that knowledge they choose a combination of inputs to produce at a level that maximizes their profits. There is therefore heterogeneity embedded in the productivity estimates as well as simultaneity bias in the selection of inputs. There are two more sources of estimation problems: self-selection bias, as firms with higher productivity are more likely to remain in the market, while firms with low productivity are more likely to leave; and measurement errors. All of these problems are sources of endogeneity and, if a least square estimation is applied, this leads to biased and inconsistent estimates.

To address endogeneity problems and control for heterogeneity of individuals this research estimates production functions with instrumental variables and fixed effects. Given that for the period under study firms faced a deep banking-debt-currency crisis that was halted with the adoption of the US dollar as the domestic currency, the study also includes time-specific effects. The analysis also adopts a dynamic panel specification that tries to account for heterogeneity and simultaneity. The study constructs indexes of firm and aggregate productivity, and analyzes a series of correlations between the measure of productivity and trade variables, controlling for events that happened in the period under study.

The questions this study asks are: (i) How has productivity evolved during the period 1997-2003 in manufacturing sectors in Ecuador after trade reforms were implemented in this country?, (ii) Is there evidence of productivity gains coming from either own-plants' improved productivity or from reshuffling resources from less to more productive units, or from both, in the Ecuadorian manufacturing industries?, (iii) Is there a significant association between trade openness and productivity in Ecuadorian manufacturing industries?, (iv) Are export-oriented and import competing industries more productive after trade liberalization?

Results indicate that there has been increased aggregate productivity in some manufacturing industries. Food processing, apparel and leather, and furniture are the industries that end up with growth at the end of the study period, 2003 (27 percent, 15 percent, and 8 percent, respectively). Other sectors, such as basic metals and metal products, and machinery, equipment and vehicles show a considerable decrease in productivity at the end of the study period, with a 28 percent point loss and a 10 percent point loss, respectively. Sectors like textiles, wood and paper, and chemicals, rubber, plastics, and nonmetallic products present a slightly decreased aggregate productivity in 2003. Aggregate productivity gains seem to stem from both (i) a contribution of more output being produced by more productive establishments (a positive "reshuffling effect") and, (ii) an increased (or at least not decreasing) own plant's productivity at the end of the study period. The results suggest a positive and significant impact of trade openness on export oriented manufacturing establishments, but after 2000, this positive impact seems to be outweighed by the negative impacts on productivity of economic events that have taken place since 2000.

The following section gives an overview of the main economic events in the Ecuadorian economy during the period under study. Section 3 presents a brief review of the relevant literature that links trade liberalization to effects on productivity. Section 4 presents the estimation method and discusses the empirical hurdles involved in productivity estimations. Section 5 presents the data and summary statistics, while section 6 discusses the results. Section 7 gives concluding remarks. A data appendix discusses data issues in more detail.

2. Trade liberalization in Ecuador

Ecuador is an economy that experienced an increase in trade openness in the years under study. The degree of openness of the Ecuadorian economy went from 35 percent in 1993 to 45 percent in 2003.[2] An increase in both exports and imports has contributed to this greater openness. In 2004, Ecuador's total imports reached US$ 7.86 billion, more than double what they were in 1994. For the period 1994-2004 there was an annual average growth rate of 14 percent for total imports. During the same period, exports grew at an annual average of 9 percent. Several factors may have contributed to this greater openness, such as tariff reform, important reductions to import restrictions, export promotion laws, modernization of trade institutions, the simplification of trade procedures, the consolidation of trade integration by the Andean Community, and trade preferences that Ecuador receives from the U.S. (ATPA and ATPDEA).[3]

The key changes in trade policies that took placed in the 1990s in Ecuador implied a turnaround in trade policy from an import substitution policy to an export-oriented, less protective, trade policy. The most important changes in tariffs aimed at reducing protectionism were concluded in 1995 (see Appendix 2: Tariff reform in Ecuador). If we analyze the composition of imports by economic use, we can also see that Ecuadorian imports experienced a few changes in the pattern of imports in the last decade or so. Three striking changes are: i) the increase in the share of consumption-good imports in total imports, from an annual average percentage share of 21 for 1995-99 to an annual average of 27 percent for 2000-04, ii) the decrease in the share of imports of inputs in total imports in the same periods from an annual 42 percent to an annual 37 percentage share, and, iii) the

[2] The openness indicator is measured as imports plus exports as a percentage of gross domestic product.

[3] ATPA (Andean Trade Promotion Act, December 1991-December 2001) and ATPDEA (Andean Trade Protection and Drug Eradication Act, December 2001-December 2006) are the unilateral trade preferences that the U.S. gives to Andean countries. Under these trade preferences Andean products enter the U.S. free of tariffs and import taxes. According to studies by the Andean Community (See CAN 2001, 2004) the Ecuadorian sectors that have benefited the most in terms of jobs created, production and exports generated from the enactment and implementation of these two acts include flowers, tuna, and petroleum.

decrease in the share of imports of capital goods in total imports from 31 percent to 28 percent in the same periods.

To foster exports, in 1997 Ecuador established an institution responsible for implementing export promotion policy and for attracting foreign investment: The Export Promotion and Investment Corporation (CORPEI).

In the 1990s Ecuador joined the efforts of the other Andean Community Nations' members to consolidate the Andean market. Since the 1990s, Ecuador has also signed trade agreements and economic cooperation agreements with Chile, Argentina, Paraguay, Uruguay, Mexico, Cuba, and Brazil.

Three other major recent changes in the Ecuadorian economy are the adoption of the US dollar as the official currency of Ecuador, the phenomenon of high remittances from Ecuadorians living abroad, and the increase in oil exports (mainly due to high oil prices, and not to increased output volume).

In the late 1990s Ecuadorians endured a sum-cum currency-debt-financial crisis that ended with the adoption of the US dollar as Ecuador's official currency in January 2000. In 1999, the Ecuadorian gross domestic product fell by 6.3 percent in real terms. After dollarization was implemented, the inflation rate converged very slowly to levels close to those of US inflation. Inflation in Ecuador was 52.2% in 1999 and reached a peak of 96.1% in 2000. Prices increased at a slower pace in 2001 (37.7 %) and in 2002 (12.5%), to finally experience one-digit inflation in 2003 with 7.9%, and only 2.7% in 2004.

Since the late 1990s, many Ecuadorians have emigrated, leaving behind their families. These Ecuadorian migrants have been sending money back to their families in Ecuador on a continuous basis. These remittances are an important source of US dollars for this economy. From 1999 to 2004, Ecuador received an annual average of US$ 1.4 billion in total remittances (or an annual average share of 6.4 percent of the GDP for that period). Remittances are the second source of US dollars for this dollarized economy, just behind oil exports revenues and ahead of banana exports. See figure 1.

Since the early 2000s, high oil prices have explained a huge increase in Ecuadorian oil exports. In 1995-99 the average annual share of exports of oil and oil-products in total exports was 31 percent (therefore, the average annual export share of non-oil products was 69 percent). For the period 2000-04 the average annual export share of oil and oil-products reached 46 percent. As figure 2 shows, the big surplus in oil-trade balances has determined the surplus in the total trade balance, as the non-oil trade balance has been in deficit during those periods.

It is interesting to note that in the first half of the period under study (1997-2000) the real effective exchange rate in Ecuador depreciated, whereas in the second half (2000-2004), the RER was sharply appreciated (Figure 3). A large influx of foreign capital (brought about by high remittances, direct investments in the oil sector, and high oil prices received for Ecuadorian oil exports) since the early 2000s might have brought a "Dutch disease" phenomenon to the Ecuadorian economy.[4] The increase in foreign capital inflows distributed to households increases demand for domestic and imported goods (the share of each depends on the elasticity of substitution between these two types of goods). An increased demand for nontradables increases their price relative to that of exports, which leads to a real exchange rate appreciation. This real exchange rate appreciation moves resources out of export sectors to the nontradable sector. As Essama-Nssah (2005) points out, a decline of the export sector may explain a fall in intermediate imports (as seen before). It may be useful to keep in mind this chain of events in order to understand later (in the analysis of productivity effects by trade sector), some developments observed in export sectors. Further studies need to be undertaken in order to ascertain whether or not Ecuador has been afflicted by the Dutch disease.

3. Productivity and trade liberalization: a brief survey

Economic theories indicate that increased access to foreign markets may have an effect on firms' productivity through several channels that can be broadly summarized as: increased competitive pressures, changes in market shares, increased access to technological improvements, and spillovers. Whether these effects are positive or negative depends, according to economic theory, on the market structure and the type of trade instruments applied (Tybout 2000).

Trade liberalization may bring increased competition for import competing firms stemming from the threat of foreign firms, which reduces market power in import

[4] In the economic literature, Dutch disease refers to the adverse effect that real exchange rate appreciation – brought about by high capital inflows-may have on the tradable sectors in an economy.

competing firms. Increased competition in the presence of unexploited economies of scale may encourage domestic firms to produce more, gaining some scale efficiency in the process. But not all domestic firms may be able to stand foreign competition. The net effect of trade liberalization depends on which sectors contract and which sectors expand.

Trade liberalization may allow domestic firms access to cheaper and better technology and better quality inputs and managerial skills from abroad (see Miller and Upadhyay 2000, Baily and Gersbach 1995).

Tybout (2000) highlights the dynamic effects of trade policies through investment decisions and/or the diffusion of technology and knowledge. The effects of trade policies on productivity in a dynamic context can, again, be either positive or negative, depending upon what assumption and what trade policy instrument is applied.

The empirical literature that studies the effects of policy changes on productivity has followed two approaches: the representative firm approach (implemented using sectoral- or macro-level data[5]), and the approach that recognizes heterogeneity (applied using micro-level data). For developing countries in particular, the recent availability of establishment data as well as the switch from protective to trade liberalization policies has allowed researchers to undertake a micro level approach to the analysis of productivity impacts of trade openness.

Using the heterogeneity approach it is possible to study important issues related to productivity that cannot be tackled under the representative firm approach, although this is done at a cost because under heterogeneity a host of problems arise such as data availability, data quality, and simultaneity, which may be more difficult to solve than if using macro-level data. The heterogeneity approach, through the use of establishments' data, not only enables the study of contributions to plants' productivity improvements common to all plants (such as exploitation of economies of scale and intra-plant changes in resource allocation –that can also be studied under the macro or representative firms-approach) but also permits to address issues specific to each plant (heterogeneity effects) due to entry/exit, and the reshuffling of resources between plants.

Tybout (1996), chapter 3, summarizes two customary ways to measure productivity that are followed in studies that use firm-level data. One type of these studies follows the

[5] Some studies that use macro-level data find evidence of significant relationships between trade openness and productivity. See, for instance, Edwards (1998).

traditional measure of productivity à la Solow and constructs Tornqvist indexes of productivity, plant-by-plant.[6] The second type of approach begins by estimating a production function (with parametric or non-parametric techniques); it then constructs a measure of productivity by plants, which is later used to construct industry wide productivity series. These industry-wide time series can be decomposed into terms that describe three main sources of productivity changes at the plant level: (i) intra-plant productivity effects (the subject of the representative plan productivity analysis), (ii) effects of market share reallocations between plants (reshuffling effects), and (iii) turnover effects or the net effects of entries and exits of plants. The last two effects capture the heterogeneity effects of plants. Finally, to analyze the effects of trade policies on productivity, micro-level data studies correlate the measures of productivity with proxies for trade liberalization (or protection) measures. The present study follows this second approach.

It is relatively recently that studies have used micro data for Latin American countries to explore the relationship between productivity and trade. A key limitation in this type of study has been the lack of quality micro-level data. On the contrary, the literature that addresses productivity issues using firm-level data for industrialized countries is much more extense. Bartelsman and Doms (2000) survey these empirical studies. It is interesting to note that according to these authors, the link between exposure to foreign markets and productivity improvements has not yet been established.

Tybout (2000) and Epifani (2003) survey the possible effects of trade policies on manufacturing firms in developing countries. Among these studies, some try to determine whether internal economies of scale explain correlation between trade liberalization and productivity. Their conclusions suggest that scale efficiency gains are minor and not correlated with trade liberalization (Tybout and Westbrook 1995). Plant-level studies find that it is the re-allocation of resources from less to more productive plants that explains productivity gains (Pavcnik 2002, Tybout 2001, Tybout and Westbrook 1995).

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[6] Tybout (1996) illustrates that a Tornqvist index can be expressed as a Divisia index,

$$\varepsilon_{y,t} = (dy/dt) / y - \Sigma_{i=1} s_i [(dx_j/dt) / x_i])$$

where $\varepsilon_{y,t}$ is the estimator of total factor productivity growth (TFP), $(dy/dt)/y$ is total output growth, s_i are factor shares, and $(dx_j/dt)/x_i$ are input growth rates. This expression embedded a key assumption that each factor is paid the value of its marginal product.

Other studies also estimate if there are turnover effects linked to trade policies. Using plant data for Chile 1975-85, Tybout (1996) finds that net exit increased aggregate productivity in Chile. Net exit was in fact the main component of productivity gains for import competing industries. On the contrary, for Morocco net entry led to lower aggregate productivity (Haddad, et al 1996).[7]

A third source of aggregate productivity gains associated with trade liberalization policies could come from improvements in intra-plant efficiency. Roberts (1996) finds that productivity growth can be attributed to intra-plant movements, using plant-level data for Colombia for 1977-87.

Without exploring why trade liberalization may affect productivity, some studies use plant- and industry-level data and find a positive and significant correlation between trade measures and productivity measures (Haddad 1993, Paus et. al. 2003).

Theories also point to an inverse causality: it is the more productive firms, those able to compete in foreign markets, that contribute to trade openness. This channel can exist provided there are no trade barriers that preclude firms in a country to compete abroad. Using survey data from Colombia and Morocco, Clerides, Lach and Tybout (1998) analyze the causal link between exporting activities and productivity. They find evidence that points to self-selection where relatively efficient firms become exporters. However, much work still remains to be done to examine the association and causality between trade and productivity, as well as the channels through which this causality may work.

Two issues that run parallel to the analysis of the effect of trade liberalization on productivity are how to measure productivity, and the hurdles involved in estimating production functions and productivity effects.

The question of how to estimate establishment productivity has been much discussed in recent literature. See Foster et. al. (1998), for a more detailed discussion of different approaches to estimating firm productivity. More recently, Van Biesebroeck (2003) compared five different techniques used to estimate productivity measures: i) index numbers, ii) data envelopment analysis, iii) instrumental variables estimation, iv) stochastic frontiers, and v) semi-parametric estimation. Using panel data from Colombian manufacturing plants Van Biesebroeck finds that the different estimation methods generate

[7] For a brief review on the empirical evidence of productivity changes due to resource re-allocation and turnover of plants see Tybout 1996, and Foster et al 1998.

similar results and conclusions: a) the correlations between alternative productivity measures are high, and b) all methods suggest that exporters are on average more productive than non-exporters and that productivity gains stemming from scale efficiency gains are small.

One of the main hurdles in estimating productivity measures is how to reduce or eliminate endogeneity caused by simultaneity bias and self-selection bias. Simultaneity bias arises because unobserved productivity in plants is actually known to the manager of the plants, who, in deciding the combinations of inputs to be used to obtain production, takes into account that knowledge of productivity. Most studies make a great deal of effort to reduce or eliminate the simultaneity problem. Widespread methods to handle simultaneity are instrumental variables and fixed effects estimation methods.[8] Self-selection bias, as explained by Pavcnik (2002), is induced by plants closing: in times of competitive pressures coming from trade liberalization, many plants may face the decision to stay in business or not. Plants will stay if their expected future profits exceed their liquidation value: more profitable plants today are more likely to anticipate higher future profits and therefore are more likely to stay in business. Moreover, the more profitable plants may have a bigger capital stock (for a given level of productivity), and so plants with bigger capital stock are more likely to stay in business than plants with lower capital stock. Pavcnik tries to control both simultaneity and self-selection bias improving upon a semi-parametric estimation method applied by Olley and Pakes (1996) to estimate production functions. Levinshon and Petrin (2003) also present a variant of Olley and Pakes using intermediate inputs to overcome simultaneity bias. For further discussion of problems involved in the estimation of production and productivity see Katayama et al (2003). The next section describes how the present study deals with endogeneity problems.

4. Estimation Method

This study draws on the current literature focusing on the productivity effects of trade liberalization to design an estimation strategy to assess whether trade openness in Ecuador has indeed had an impact on the productivity of Ecuadorian Manufacturing establishments. The study follows a three-step estimation strategy. First, it estimates a production function

[8] In the presence of endogeneity, least squares estimates become inconsistent.

to construct a productivity measure by establishment. This study attempts to estimate unbiased and consistent coefficient estimates by addressing the problem of endogeneity, which usually arises in the context of unobserved productivity. This research tries to control for the presence of key economic events (crisis and dollarization) that took place in Ecuador during the years of our study. Secondly, the study constructs an aggregate productivity measure and decomposes it in two terms: one that represents changes in intra-plant productivity, and the other that captures the reshuffling of resources between plants. In the third step this study runs regressions to find any significant correlation that could exist between trade openness indicators and the study's measure of productivity by plant.

Production function and productivity estimates

The empirical part begins with a customary production function of the Cobb-Douglas type that is assumed to reflect the true production of a given industry.

$$Y_{it} = Ae^{\omega it}K_{it}^{\beta k} L_{it}^{\beta l} \qquad (1)$$

where,

$$\omega_{it} = \mu_i + \lambda_t + \nu_{it} \qquad (1')$$

and where *i* and *t* are the plant and time subscripts, respectively (the industry subscripts are omitted); Y represents value added (total production less raw materials), L represents number of workers (blue collar and white collar), and K represents the stock of capital. All observable variables are measured in real terms. A is technical efficiency within an industry, and the term ω_{it} represents productivity due to three sources: (i) μ_i, plant-specific efficiency, (ii) λ_t, a plant-invariant time-varying effect representing economic events (like macroeconomic crises) that could affect productivity in an industry, and (iii) ν_{it}, reflects plant-specific time varying events that may affect the productivity of firms across time.

In logarithms, the true production function can be expressed as:

$$\ln Y_{it} = \beta_0 + \beta_l \ln L_{it} + \beta_k \ln K_{it} + \omega_{it} \qquad (2)$$

This research is concerned with the terms β_0 (=lnA) and ω_{it} as the time-varying plant-specific productivity measure. One can think of two ways to address the empirical estimation of the true model in (2), where a problem is that the productivity term is not observable to the econometrician but may be observable to the manager of a firm, in which case endogeneity arises. One way to estimate this production function is to keep the productivity term as an error component. Another way is to assume productivity as an omitted variable and try to model and proxy it.

1) *Applying error component models*.- Think of μ_i and λ_t as components of the error in an estimation (for the moment ignore the time-varying plant-specific term, ν_{it}) and obtain estimates of the following equation:

$$\ln Y_{it} = \hat{\beta}_0 + \hat{\beta}_l \ln L_{it} + \hat{\beta}_k \ln K_{it} + \hat{\mu}_i + \hat{\lambda}_t + \hat{\varepsilon}_{it} \tag{3}$$

$$\varepsilon_{it} = \nu_{it} + \eta_{it} \tag{3'}$$

where η_{it} has a distribution with mean zero and constant variance and is the random error component that is not known either to the manager or to the econometrician. μ_i and λ_t (and ν_{it}) may be observable to the manager of the plant but not to the econometrician. In this case these error components will be correlated with the exogenous variables, in particular labor.[9] This simultaneity makes labor endogenous. A least squares estimation of (3) will lead to biased and inconsistent estimates of the true βs. Numerous studies indicate that there would be an upward bias of OLS estimators (at least in large samples).

To get around the endogeneity of labor, this study applies instrumental variable (IV) estimation techniques using one-time lagged labor as an instrument for itself. The study tries to capture the plant-specific effect and time varying effect using two-way fixed-effect estimators.[10] In this estimation the sum of both β_0 and μ_i gives us our estimation of plant productivity, to which we add the random error component (this study assumes that this term includes both time-varying firm-specific effects related to productivity, and a random noisy effect). Unfortunately, this study has no way of separating these terms at this stage of the estimation. In the presence of unaccounted productivity terms there would still be an

[9] Haddad (1993) shows how a manager's knowledge of efficiency disturbances affects the manager's employment decisions. See also Marschak and Andrews (1944).

[10] Baltagi (2005), chapter 3, deals with estimation issues related to the two-way error component regression model.

unaccounted correlation between input variables and the error term. In this case, the fixed effects estimator is still inconsistent. The literature points out that at least in large samples, fixed effects estimators are biased downwards (see Bond 2000, for instance). Bond considers that the opposite bias of the OLS and the fixed effects estimators are useful because it is expected that a possible consistent estimator of the production function may lie between these two types of estimates, or "at least not be significantly higher than the OLS estimates or significantly lower than the latter (fixed effects or within group estimates)."

2) *Using indicators for the unobservables*.- Estimates from (3) present a problem. If the random error component does not include further productivity effects (known to the manager), so that productivity effects are given only by β_0 and μ_i, the estimates imply an assumption of unchanging productivity, and as Pavcnik (2002) points out, this seems implausible during times of structural adjustments such as those of trade liberalization. Or, if there is indeed an additional error component (not modeled above) not observable to the econometrician –but known to the manager- we may still have an unsolved endogeneity problem. This study tries to apply indicators that are time-varying measures of a plant's productivity. In other words the study thinks of the true model with ω_{it} as a case of omitted variables and tries to model the productivity term ω_{it}.

This research takes advantage of dynamic panel data estimation techniques and, following Blundell and Bond (1998, 2000; as explained in Van Biesebroeck, 2003), the study estimates a production function with an individual-specific and time-varying error component ω_{it}. Those authors model the productivity term as a serially correlated process AR(1), where productivity at time *t* is expected to depend on the previous year's productivity performance. This specification also includes time specific effects.

$$\ln Y_{it} = \beta_t + \beta_l \ln L_{it} + \beta_k \ln K_{it} + \omega_i + \omega_{it} + \varepsilon_{it} \qquad (6)$$

$$\omega_{it} = \rho\, \omega_{i\,t-1} + \eta_{it} \qquad |\rho| < 1 \qquad (6')$$

where both the η_{it} and the ε_{it} (the random error component) terms are distributed with mean zero and constant variance.

Combining (6) and (6') we obtain the following expression:

$$\ln Y_{it} = \beta_l \ln L_{it} + \rho\beta_l \ln L_{it-1} + \beta_k \ln K_{it} + \rho\beta_k \ln K_{it-1} + \rho \ln Y_{it-1} + \beta_t^* + \omega_i^* + \varepsilon_{it}^* \qquad (7)$$

where,

$\beta_t^* = (\beta_t - \rho \beta_{t-1})$
$\omega_i^* = \omega_i (1 - \rho)$
$\varepsilon_{it}^* = (\eta_{it} + \varepsilon_{it} + \rho \varepsilon_{it-1})$

This productivity dynamic model is estimated with an error term specified as a two-way error component model. The study applies the Arellano and Bond two-step estimator, taking the twice lagged values of inputs as instruments for the lagged production (value added) and lagged inputs (as before, inputs and lagged output can be correlated with the composite error). Our time-varying plant specific productivity term should be given by the residual of (7). Bond (2000) stresses that the instruments available for an equation in first-differences (such as (7)) may be weak if the series have near unit root properties. In this case IV estimators may have serious finite sample (downward) biases (see also Blundell and Bond (1998)). Bond shows that applying an extended estimator called the systems GMM (because it includes a combination of equations in first-differences and an equation in levels), leads to estimators with small finite sample bias and greater precision when the shock is modeled as an autoregresive component in the presence of persistent series.

Productivity Index

After estimating the coefficients of the production function for each of the eight industry groups considered (food processing; textiles; apparel and leather; wood and paper; chemicals, rubber, plastics and nonmetallic products; basic metal and metal products; machinery equipment and vehicles; and, furniture) the study attempts to construct a time-varying productivity index for each establishment. Within each industry, the study takes as a measure of productivity the *deviations* from actual output (actual less predicted output) of each establishment and compares them with the *deviations* from the actual output of a "representative plant". The actual output of the representative plant is equal to the average actual output of all plants in the same industry. The predicted output of the representative plant is the output that results from multiplying the coefficient estimates by the average of the corresponding input. That is,

$$pr_{it} = [y_{it} - \hat{\beta}_l \, l_{it} - \hat{\beta}_k \, k_{it}] - [y_r - \hat{y}_r]$$

where,

$y_r = \overline{y}_{it}$

and,

$\hat{y}_r = \hat{\beta}_l \, \overline{l}_{it} - \hat{\beta}_k \, \overline{k}_{it}$

To check the importance of productivity gains stemming from the "reshuffling" of resources from less to more efficient plants in a given industry, this research computes an aggregate industry productivity measure for each year. This study takes as weights total production share of each establishment on the total production of the industry that it belongs to.

$W_t = \Sigma_i \, s_{it} \, pr_{it}$

Where s_{it} is the production share of plant *i* from industry *j* in the total production of that industry (again, we omit the industry index).

As is customary in papers that apply a productivity index approach (see for instance, Tybout 1996, Pavcnik 2002), this study decomposes the weighted aggregated productivity measure "W_t" into two parts:

a) First, the part that explains the contributions of intra-plant productivity changes, and
b) Second, the part that explains the contribution to aggregated productivity resulting from the reallocation of market shares and resources across establishments of different productivity levels. In the literature this is known as the covariance term. If the covariance is positive, more output is being produced by the more efficient plants.

This study follows Pavcnik (2002) in interpreting the results of positive and increasing covariance over the period analyzed as indicative of there being some positive effects of trade liberalization on aggregate productivity.

Finally, this study takes the measure of productivity by plants and correlates this measurement with some trade openness measurements. The corresponding trade regressions and measurements are explained in the section that shows the results of the impact of trade openness on productivity.

5. Data

This study analyzes manufacturing establishment data from Ecuador's Annual Survey of Manufacturing and Mining. The Ecuadorian Institute of Statistics and Census (INEC, by its acronym in Spanish) provided the establishment data for the period 1997 through 2003, inclusive. For each establishment we observe data on number of employees, raw materials, production, depreciation, investment, ISIC-r.3 code (International Standard Industrial Classification, revision 3), and establishment identity code. The identity code allows us to track a unit over time. Table 1 presents some summary statistics.

Data on trade and effective protection tariffs are from the trade databases of the Central Bank of Ecuador. The trade data, combined with the data on total production from the manufacturing dataset, allow this study to construct shares of imports over total production, shares of exports over total production, and import penetration variable at the 4-digit ISIC codes, by year, for the period 1997-2003. Averages of these shares over the whole period for each 4-digit ISIC code are calculated and presented. Based on these average percentage shares the study classifies establishments as belonging to an industry that is import-competing (when the import share exceeds 26 percent), export oriented (when the export share is above 35 percent), or non-tradable (when the export share is below 35 percent and the import share is below 26 percent). In the few cases where these thresholds did not give a clear-cut classification, this study obtains a trade-orientation classification by applying the same threshold criteria to trade-production ratios at the 2-digit level of the ISIC classification. Table 2 and 3 show the results of this classification.[11] Appendix 1 gives further details about the data preparation steps.

This paper classifies industries into high, medium, and low effective rate of protection industries (ERP). We have data on ERP for years 1996 and 2001. We take an average of these years and take the arbitrary thresholds of below 13 percent ERP as "low", above 16 percent as "high", and anything in between as "medium".

[11] This way of classifying industries by their trade orientation is ad-hoc and may seem arbitrary. But it was necessary to apply some rule to classify industries by trade orientation as one of the goals of this research is to study any significant differences in productivity between establishments and industries that produce import-competing, export-oriented and nontradable (in foreign markets) products.

6. Estimation results

Table 4 reports the estimates of the production function applying ordinary least squares, two-way fixed effects with instrumental variables, and GMM (in difference estimator). The establishments were grouped into eight types of industries: 1.- food processing; 2.- textiles; 3.- apparel and leather; 4.- wood and paper; 5.- chemicals, rubber, plastics, and nonmetallic products; 6.- basic metals and metal products; 7.- machinery, equipment and vehicles; and, 8.- furniture.

As discussed in the estimation method section, OLS estimates are inconsistent and present an upward bias due to endogeneity problems. The results present least squares estimates to provide an upward bound for the coefficients of the production function. To try to control for simultaneity in the choice of inputs and productivity effects, which cause endogeneity, this study applies instrumental variables estimation, including a one-lagged labor as instrument, as well as two-way components to account for individual heterogeneity and key economic events that took place during the period under study (such as the 1999 economic crisis and the adoption of the U.S. dollar as the Ecuadorian currency since 2000).

Column (1) in Table 4 presents the results of the IV-two way fixed effects estimation. As expected, IV estimates are lower than OLS estimates, except for a slightly higher value of the labor estimate in the wood and paper industry (this same coefficient, as it will be later seen, turns out to be negative when the GMM estimator is applied). IV estimates for labor and capital are positive and significant, except for the capital coefficient in the apparel and leather, chemicals and others, basic metals, and furniture industries, where they turn out to be not significant.

The in-difference (dynamic) GMM estimates are reported in column 2 of Table 4. The coefficient estimates are, unexpectedly, lower than the IV estimates. All labor coefficients are positive and significant, except for the cases of both wood and paper, and basic metal industries. In contrast, capital coefficients are negative and not significant (in six of the eight industries).

Given the interest of current research in the effects of trade openness on productivity, this paper presents results of coefficient estimates of production functions using data from industries classified by trade orientation (Table 5). The regressions estimate production functions using establishment data from export-oriented, import competing, and nontradable industries. These production function estimate results will later be used to construct productivity measures by trade orientation of manufacturing establishments. Again the regressions present both OLS and IV estimates with time dummy variables to control for the economic events we have mentioned above. IV estimates of the input coefficients are lower than their corresponding OLS estimates. It is interesting to note that, according to the IV results, the dummies corresponding to pre- and crisis years seem to have a negative and significant impact on the production of import-competing industries, whereas the dummy for the immediate post-dollarization year has a positive and significant effect in the same industries. In striking contrast, time dummies for the post-dollarization period seem to have a negative and significant effect on production for the export-oriented industries.

Productivity measures

Based on the results from the IV production function estimates, this study constructs a productivity measure. As explained in section 4, this research follows the literature that takes as a total productivity measure, for a given establishment, the difference between the part of the production function regression not explained by the inputs coefficients of the establishment, and a similar unexplained part corresponding to an average representative plant in a given industry. This empirical study then constructs an aggregate productivity measure using total production weights, and decomposes it into two parts: own-plant productivity effects and reshuffling effects. The study builds an index of total productivity with year 1997 as the base year. Table 6 summarizes the results.

Food processing, apparel and leather, and furniture are the only industries that end up with growth at the end of our study period, 2003 (27 percent, 15 percent, and 8 percent, respectively). Basic metals and metal products is the industry that ends with biggest decrease in productivity at the end of the period, with a 28 percentage point loss. It is followed by machinery, equipment and vehicles with a 10 percent loss over the same period.

The decomposition of the aggregate productivity measure suggests that there has been a positive contribution of reshuffling effects (covariance term), which is, that more output has been produced by more efficient establishments across all industries. However, the positive reshuffling effects have been decreasing over time, in particular for the basic metals and product metals industry as well as the machinery, equipment and vehicles industry. On the other hand, for those industries that showed an aggregate productivity growth at the end of 2003, the covariance term was increasing. Own-plant productivity contributions to total aggregate productivity were generally positive in most industries. Exceptions are the textile and the chemicals-plastic-rubber-and-nonmetal industries, for which own-plant productivity effects are negative, albeit constant over time. Interestingly, the machinery, equipment and vehicle industry shows a positive own-plant effect and ends up with an increased own-plant productivity effect in 2003 (compared to 1997).

Table 7 takes the classification of the manufacturing industries by trade orientation at the 4-digit ISIC level (obtained as explained in our previous data section), and calculates their aggregate productivity. The results show that import-competing and nontradable industries experienced productivity growth every year from 1997 to 2003 (again, compared to 1997). Establishments' productivity in export-oriented industries grew in years 1998-2000 –at a higher rate than in import-competing and nontradable industries-, barely grew in 2001, and fell in years 2002 and 2003 (post-dollarization years).[12]

Trade correlations with productivity

To explore any significant correlation between the measures of productivity by establishment[13] and trade openness, this study fits three different equations that focus on three different trade variables: a) trade orientation, b) real effective exchange rate, and c) effective rate of protection. The results for all these estimations are presented in Table 8.

Following Pavcnik (2002), the present study regresses productivity by establishments on a time dummy, a trade orientation variable (which indicates if a given establishment belongs to an export oriented, import competing, or nontradable industry), and an interaction term between the time dummies and the trade orientation variables. The results of OLS estimation suggest that being in an export-oriented industry has a positive and

[12] Similar results on productivity are also obtained when a production function is estimated using total production instead of value added. As the data appendix shows, total production is measured as a total sales variable and as such is subject to issues in differentiating between a plant's true productivity and a plant's specific markup when plants charge different markups.

[13] The results from the two-way fixed effect Instrumental Variable estimates are used.

significant effect on total productivity by establishment. However, there is also a significantly negative effect for the export oriented plants stemming from the interaction term between export-oriented industry and the dummy of the period 2001-2003. This negative interaction term outweighs the positive effect on productivity of belonging to an export oriented industry.

When the regressions include fixed effects to control for any industry-specific effects (according to the eight-type industry classification mentioned above) the results are similar regarding the interaction term between export-oriented industry and the 2001-2003 dummy: a negative and significant correlation (and of similar magnitude) on productivity arises from being in an export-oriented industry in years 2001-2003 (with respect to the omitted class of nontradables, 1997-1998 period).

The second type of regression adds the real effective exchange rate (REER) to the trade equation above as well as an interaction term between the REER and the trade orientation dummy variable (whether the establishment belongs to an export-oriented or an import competing industry). There are no significant effects to report, except for the still negative and significant effect (albeit at the 10 percent level) of the interaction term export oriented – dummy years 2001-2003.

Finally, this study runs a regression that tries to explore whether establishments that are in a high- or a low- effective exchange rate of protection (ERP) industry are more productive than those in a medium-protected industry. This last regression also includes the real exchange rate (RER), and an import penetration variable. Both high- and low-exchange rate of protection dummy variables have a positive and significant impact on aggregate productivity. Whether an establishment is in a low- or a high-ERP industry makes no difference, as in both cases productivity is positively impacted. The import penetration variable turns out to have a negative effect on productivity, although this variable is significant at the 9 percent level.

7. Concluding remarks

The present research studied how productivity evolved in Ecuadorian manufacturing industries during the 1997-2003 period after trade reforms were fully implemented in Ecuador, and whether trade openness had any significant impact on productivity in those industries. The study used manufacturing establishment data and panel data methods standard to the productivity branch literature. The regressions tried to control for key economic events that happened in this country in the late 1990s and early 2000s, including the 1999 economic crisis and the adoption of the U.S. dollar since year 2000. Of particular interest to Ecuador is the relationship between trade openness and productivity, because a key reason of policy makers in reducing trade barriers and stimulating export activities is to reap the positive effects of such openness on productivity.

The results suggest evidence of increased aggregate productivity in some Ecuadorian manufacturing industries, such as food processing, apparel and leather, and furniture. But the results suggest that productivity decreased somewhat considerably in sectors such as basic metals, and machinery-equipment-vehicles, and slightly in other sectors such as textiles, wood and paper, and chemicals, rubber, plastics and nonmetallic products. Increased aggregate productivity might be due to both a positive contribution stemming from the reshuffling of resources towards more productive establishments and slightly increased own-plant's productivity.[14]

The results suggest that trade openness has had a positive and significant effect on productivity in Ecuadorian export-oriented manufacturing industries. But this result has to be combined with other results, which suggest that economic events that affected all firms in the years under study also played an important role in affecting productivity performance in Ecuadorian industrial establishments. Economic events after 2000 are found to have had a negative impact on productivity, and in particular, a significantly negative impact on the productivity of establishments in export-oriented manufacturing industries.

In order to present robust productivity estimates, the study fits production functions with both total production and value added. The study finds that the productivity effects for 1997-2003 behave in a similar fashion regardless of the measure this study employs in the production function (output or value added).

This research addresses the problem of simultaneity that arises when the private knowledge of the plant's productivity affects its input selection by applying instrumental variables and GMM estimation techniques.

[14] Because the current data used cannot distinguish exit firms from temporary drop-outs in the survey, this research cannot analyze turnover effects among individual establishments when addressing the issue of how trade can alter industry productivity.

Using the productivity measure obtained from production function estimates as our dependant variable, we empirically identify the effects of Ecuador's trade openness on productivity. The techniques applied try to account for variables that may affect productivity but are not directly related to trade policies. We use sensitivity analysis to ensure our results are robust to the measures of productivity and trade openness used. Trade liberalization policies are represented by effective rates of protection. We also use real effective exchange rates, and trade orientation as our trade variables.

A note of caution is in order: although this research concludes that results *suggest* that trade openness has had a positive and significant effect on productivity in export-oriented manufacturing industries in Ecuador, it is important to acknowledge that endogeneity problems do not make the causality clear. It may be the case that it was more productive establishments that self-selected themselves to perform export-oriented activities (or that are able to stay in business).

The issues of self-selection and heterogeneity (that lead to endogeneity problems) in the production function estimates) are addressed by using error component and instrumental variable models.

Timing may also be an issue. The data available corresponds to a period after the main trade reform –oriented to liberalize and open trade markets– were undertaken in Ecuador. Sweeping tariff reforms were finalized around 1995. (Appendix 2 presents some key figures and dates of the 1990s tariffs reforms in Ecuador). However, after 1995 there were setbacks and additional trade reforms aimed at increasing trade openness, opening new markets, and in general, promoting exports. Unfortunately, there was no data available to conduct a "before and after" analysis. In particular, there was no micro-level data available for the period before (and during which) the most important tariffs reforms took place (1989-1995).

Another data issue that this research tried to address was how to control for events that took place during the period under study. In the late 1990s and early 2000s, Ecuador experienced major economic shocks, crises, and policy changes (other than trade policy changes). A deep banking-currency-debt crisis was halted when the US dollar was adopted as the official currency in January 2000.[15] This period of economic turmoil led many Ecuadorian to leave the country, leaving behind their relatives.[16] Since the late 1990s, remittances have constituted an important source of income for some households in Ecuador. Since the early 2000s, Ecuador has tremendously increased its surplus in the oil trade balance, due to high oil prices. In the late 1990s, the RER in Ecuador depreciated, but these changes reversed in the early 2000s, when the RER was appreciated. This study tried to control for economic events that happened in the late 1990s and early 2000s using dummy variables.

Future research work would need to focus on exploring the underlying causal mechanisms of changes in productivity in Ecuadorian establishments in manufacturing industries. For instance, it would be interesting to analyze increased access to foreign inputs and technology, competition from foreign firms, turnover effects, and scale economies effects to explain how trade liberalization policies have had any significant impact on productivity. Another interesting extension to the study of trade openness and productivity effects would be to focus on the service sector, given the growing weight of this sector in the Ecuadorian economy.

[15] Originally, it was planned to use interest rates as the variable to account for effects of dollarization, but the idea was scrapped because: (i) in Ecuador, (referential) interest rates are set by the Central Bank, (ii) small and medium establishments hardly have access to loans for productive purposes from the banking system, either from Ecuador or abroad.

[16] An analysis of impacts of migration on labor quality and analysis of any credit crunch that may have taken place in the crisis period are beyond the purposes of this study.

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APPENDIX 1: Data Preparation

a) Manufacturing data

The original data set comprised 11,072 manufacturing and mining establishments for the period 1997-2003 classified according to the International Standard Industrial Classification of All Economic Activities, revision 3, (ISICr3). The dataset was collected and made available by the Instituto Nacional de Estadísticas y Census (INEC) of Ecuador. According to the last economic census (1980), these survey data were expected to cover at least 75 percent of total production in the manufacturing and mining industries. The unit is defined as establishments in manufacturing and mining industries with at least 10 workers. The original dataset provided data on 139 variables (151 variables for years 2002 and 2003). Data from 1997 to 1999 were in sucres and from 2000 on were in US dollars. Variables in sucres were converted to US dollars using the annual average exchange rate of the International Financial Statistics from the International Monetary Fund. Nominal variables (in dollars) were converted to real variables using the GDP deflator as calculated by the Central Bank of Ecuador for the new national accounts in US dollars with base year 2000.

Variable definitions and estimation of capital stock.- The variables we construct or take from INEC data include total production, number of workers, raw materials, depreciation, investment, stock of capital, subsidies, and value added. We define each variable in what follows.

-Total production is the value of products including net increase of inventories.

-Number of workers includes blue-collar, white-collar, and non-remunerated workers.

-Raw materials include the value of materials and auxiliary inputs (including accessories and repairs, but excluding subsidies on materials received by the establishment).

-Value added is total production less raw materials (both variables as defined above).

-Depreciation is the book value of the wear and tear experienced by fixed assets of each establishment as allowed by accounting rules.

-Investment for year *t* is the result of adding up purchases of both new and old fixed assets in year *t plus* construction of fixed assets made with the establishment's own resources in year *t less* the sales of fixed assets in year *t*. This investment variable is used to construct the series of capital for each establishment.

-Stock of capital.- There was no stock of capital measure available in the database. Instead, the INEC data has a measure of balance-at-the-end-of-the-year of fixed assets that includes revalorization.[17] We build an estimate of the stock of capital in real terms for each establishment using data available in the survey and applying the perpetual inventory method (whenever a continuous series of all other data was available for each establishment).

The first step in the estimation of the series of capital stock was to calculate an initial real capital stock for each establishment. We take the variable called "balance as of December 31st of year 1997" and subtract both investment (as defined above) and an account called "revalorization and adjustments for value of market" of

[17] The "revalorization and adjustments for value of market" account originates in an accounting rule by which fixed assets can be periodically re-valued so they reflect the market value of assets instead of the book value of assets. This practice was widely followed in Ecuador when there were high inflationary processes. We observed positive values in the adjustment account for most of the establishments for the period 1997-2000 (before the adoption of the US dollar as the Ecuadorian currency abated the inflation rate to those of the US - plus a country risk premium). We do not include revalorization and adjustments in our measure of capital stock.

1997. We thus obtain a variable called "balance as of January 1st of year 1997" (notice that this variable should be equal to the variable "balance as of December 31st of year 1996"). We convert this 1997 nominal initial capital stock estimate to real terms applying a year-end version of the GDP deflator (taking the 1996 year-end GDP deflator as the deflator for the initial capital stock variable of year 1997).[18] This real initial capital stock for year 1997 is the first observation of our series of capital stock variable. To obtain an estimate of the real capital stock for year 1998 (the second year in our sample), we take the estimate of the real initial capital stock for year 1997 and add real investment for year 1997 and subtract real depreciation for year 1997 (real investment and real depreciation are obtained applying annual economy-wide deflators for gross fixed capital formation of the national accounts with base year 2000 to both nominal investment and nominal depreciation). These real estimates of capital stock for year 1998 become the initial capital stock for year 1999, to which we add real investment for year 1998 and subtract real depreciation for year 1998 to get the real stock of capital for year 1999. We continue in a similar fashion to construct the series of stock of capital for the period 1997-2003 for each establishment.

Selection of observations.- We followed a series of steps to validate and clean up our database of manufacturing data. On each step a number of observations were lost.

i) Non-manufacturing data: We started out with 11,072 observations from the manufacturing and mining survey. We excluded 374 observations in the mining and refinery industries (digits 11, 13, 14, and 23 of the ISICr3).[19] We are left with 10,698 observations from the manufacturing industry only (excluding refinery).[20]

ii) "Irregular" reporters: We checked for consistencies in the assignment of the ISIC by establishment, and eliminated those establishments that have switched back and forth of ISIC (at the 4-digit level). We also checked for consistency in entries and exits of establishments and eliminated those establishments with multiple entries and exits (that is, we eliminate those establishments that have entered or exited the sample more than once). After eliminating these irregular establishments (509 observations) –either because they switched ISICs or presented multiple entries and exits- we are left with 10,189 observations.

iii) Zero value or missing observations for key variables: We eliminated observations with zero value or missing data on number of employees, capital stock, raw material value, total production, and value added. 798 observations with zero values were eliminated. There were no observations with missing values. We are left with 9391 observations.

iv) Extraneous growth: We eliminated observations with a rate of growth in excess of 300 or -300 percent, in real terms, in total production, value added, capital, and raw material value. We identified and eliminated 1845 observations in this category. At this stage we had an unbalanced panel of 7546 observations.

Finally, since our goal is to study a balanced panel we eliminated those establishments for which we lack a complete series of observations for the variables total production, number of employees, capital, and raw materials for the whole period 1997-2003. Our final balanced panel includes 5047 observations of manufacturing establishments in Ecuador for years 1997-2003.

b) Trade data

Import and export data were taken from the trade statistics of the Central Bank of Ecuador. This dataset comes in US dollars and follows the NANDINA classification code, which is the classification applied to trade merchandise by the Andean Community of Nations (based on the Harmonized Commodity Description and Coding System (HS)). According to the World Trade Organization report on trade policies (WTO, 2005),

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[18] We use the year-end price index formula $PE_{jt} = (P_{jt}\ P_{jt+1})^{1/2}$ to impute year-end prices for year 1996 applying the GDP deflator (see Tybout 1996, for a brief discussion on imputing year-end price indexes using average annual price indexes) .

[19] We exclude the refinery industry as this industry is run by the government and is subject to domestic price controls.

[20] If an observation of an establishment was to be eliminated for a given year, the establishment was eliminated from the sample for all the years.

Ecuador's nomenclature is based on the version of NANDINA that incorporates the third amendment of the Harmonized System. We mapped the NANDINA classification into ISIC codes, revision 3, using a mapping provided by Central Bank officers. We calculated shares of import in total production, shares of exports in total production, and import penetration (the ratio of imports to consumption –defined as production minus exports plus imports) at the 2-, 3- and 4-digit of the ISICr3. We calculated an average of these shares for the period in consideration. Tables 2, and 3 present the results for the 4- and 2-digit classification.

Data on effective rates of protection are taken from Table 6A of the Central Bank document "Hechos estilizados de 31 sectores productivos en Ecuador" and from information provided directly by the Central Bank of Ecuador. Real (effective) exchange rates are taken from the International Financial statistics of the International Monetary Fund.

APPENDIX 2: Tariff Reform in Ecuador[21]

In 1990, the Ecuadorian government published its proposal for a tariff reform. The objectives of the proposed reform included:

i) promote export-growth led development
ii) foster equitable growth, and
iii) simplify and moralize customs

In that year the reform started to be implemented by incorporating Ecuadorian tariffs to the system of classification and code of common merchandise of the Andean Community Nations (the NANDINA classification). It also set new tariff rates. The minimum level was set at 0 percent and the maximum at 60 percent, except for vehicles, which reached up to 80 percent. The average nominal tariff rate was reduced to 24 percent, with 14 different levels for tariff rates. These new reduced tariffs were in striking contrast to their previous 1989 values: 290 percent for the maximum tariff rate, and 29 for the lowest tariff rate.

In 1989 two changes in tariffs were implemented. The first was adopted in January and lasted until November. This change set 9 levels for tariff rates between 0 and 40 percent, except for vehicles, which applied a 50 percent rate (except those used for public transport). The second change, adopted in November, was partial for it did not cover the whole universe of tariffs. This change established tariff rates between 0 and 35 percent, and a 40 percent tariff rate for vehicles. The average nominal tariff rate for 1991 was 17 percent.

New changes in tariff implemented in 1992 intended to provide incentives for the development of national production. It established 10 levels of tariff rates, with a minimum tariff rate of 0 percent and a maximum of 20 percent. Vehicles applied a 37 percent tariff rate. These changes brought down the average nominal tariff rate to 9 percent.

In 1994, new changes in tariffs brought the tariff structure of Ecuador closer to the levels established by the Common External Tariff of the Andean Countries. The tariff levels were set at 0, 5, 10, 15, and 20 percent, and 40 percent for vehicles. The average nominal tariff rate reached 11 percent in 1994 (this value doesn't include the tariff set for oil related products).

Sweeping tariff reforms ended in 1995 (in 1996 there were changes in the list of exceptions).

Results

[21] Text and data on this section rests heavily on Tamayo (1997), "La evolución del arancel en el Ecuador: 1990-1996," Working paper No.115, Central Bank of Ecuador, May 1997.

The first result was the simplification and reduction in number of levels of tariffs in comparison to those prevailing before 1990. The average nominal tariff rate was halved from 24 percent in 1990 to 11.3 in 1996 (and to 9.9 in 2003). This sole change together with the elimination of other restrictions to imports, stimulated import growth.

As a result of the tariff reforms, the dispersion in tariff rates was reduced from 111.7 in 1989 to 56 in 1996. The difference between the average nominal tariff rate and the effective tariff rate was also reduced. While in 1989 the nominal rate was 29 percent and the average effective rate was 8.7 percent, in 1996 the average nominal rate was 11.3 percent and the average effective reached 10 percent.

As a result of the reforms, additional taxes on imports were scrapped. This implies that the average nominal tariff rate is indeed a good indicator of the degree of tax burden of imports.

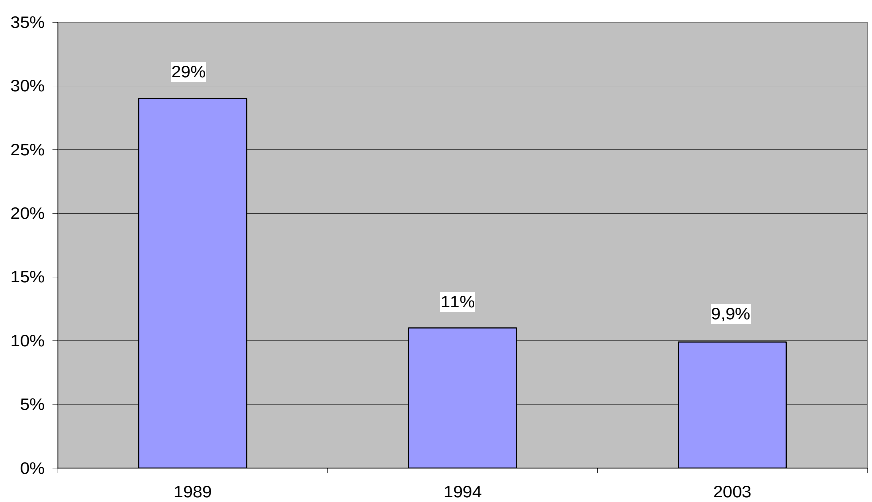
Average Nominal and Effective Tariff, and Tariff Revenues. Percentage and Millions of US$

	1990	1991	1992	1993	1994	1995	1996
Average Tariff							
All tariff lines							
-Nominal	24.3	17.2	9.3	9.3	11.8	11.3	11.3
Of tariff lines imported							
-Nominal	n.a.	17.1	9.1	9.4	11	11.1	11.2
-Effective	18.1	12.6	8.6	8.8	11.4	11.4	10
Tariff Revenues							
Expected	162.3	217.2	190.5	207.3	288.7	310.5	254.6
Received	152.8	211.6	181.8	205	285.6	307.5	251.8
Difference between expected and received	9.5	5.6	8.7	2.3	3.1	3	2.8

Source: Tamayo (1997)

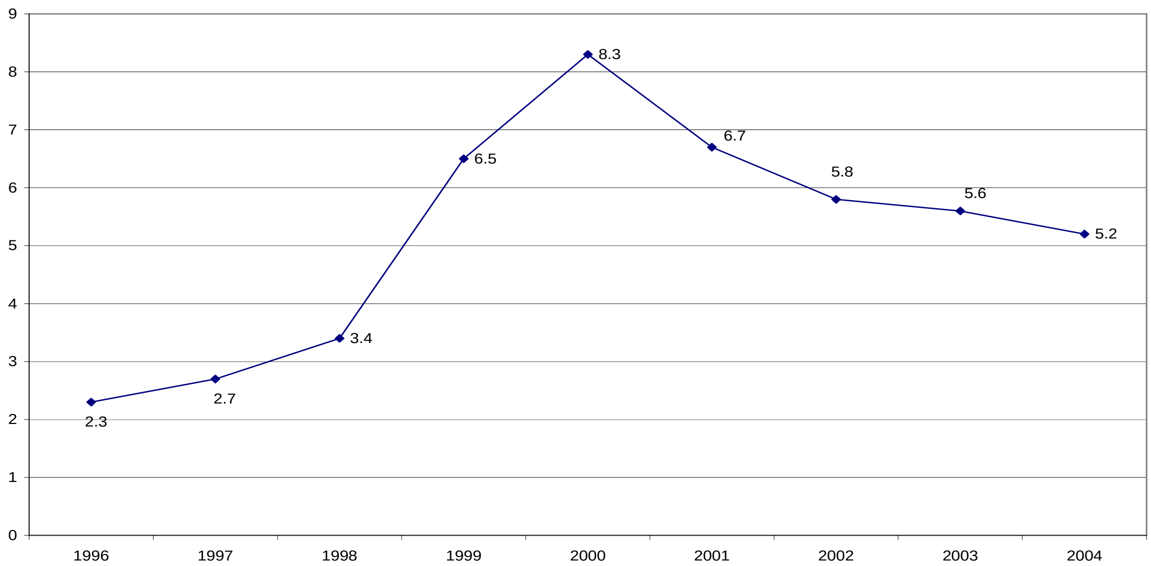
Notes: The average nominal tariff rate is calculated as a simple average, that is, it is the sum of all tariff rates divided by the total number of all tariff lines. The average effective tariff rate is the sum of the product of each tariff rate times the CIF value of the corresponding imports of each tariff line divided by the value of total imports (CIF). Data for 1996 tariff revenue received is estimated.

Ecuador: Average Nominal Tariff. Selected years



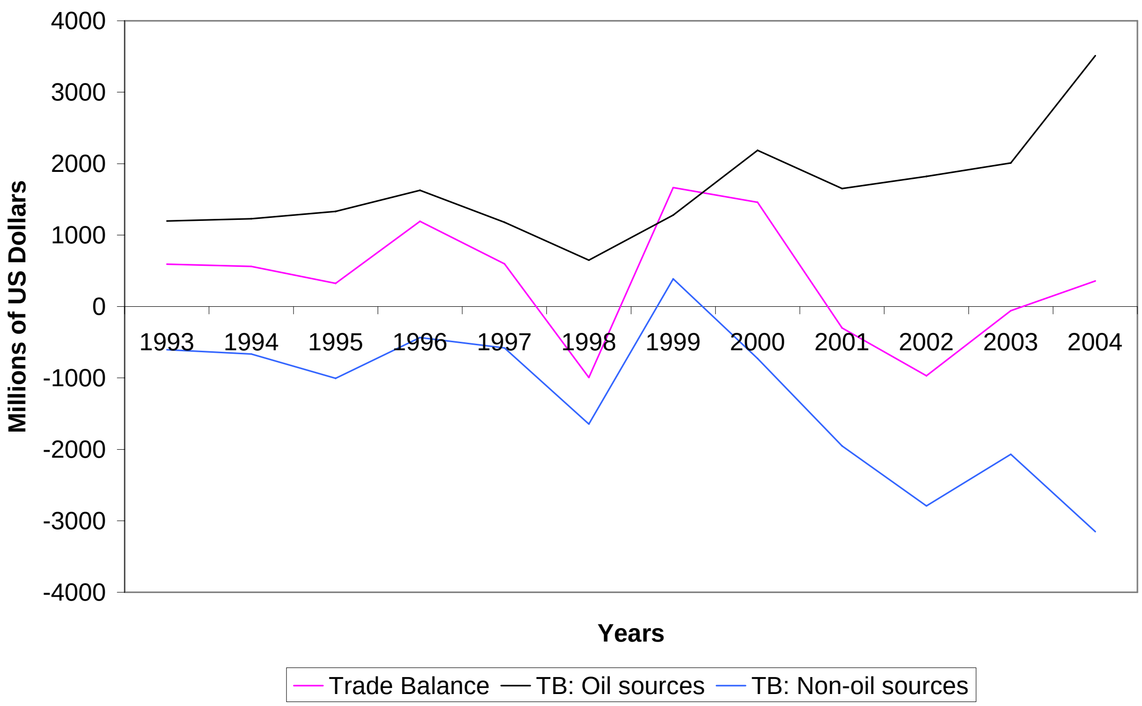
Source: COMEXI, "La Política de Comercio Exterior del Ecuador," December 2004.

Figure 1
Remittances, Percentage of GDP
1996 - 2004



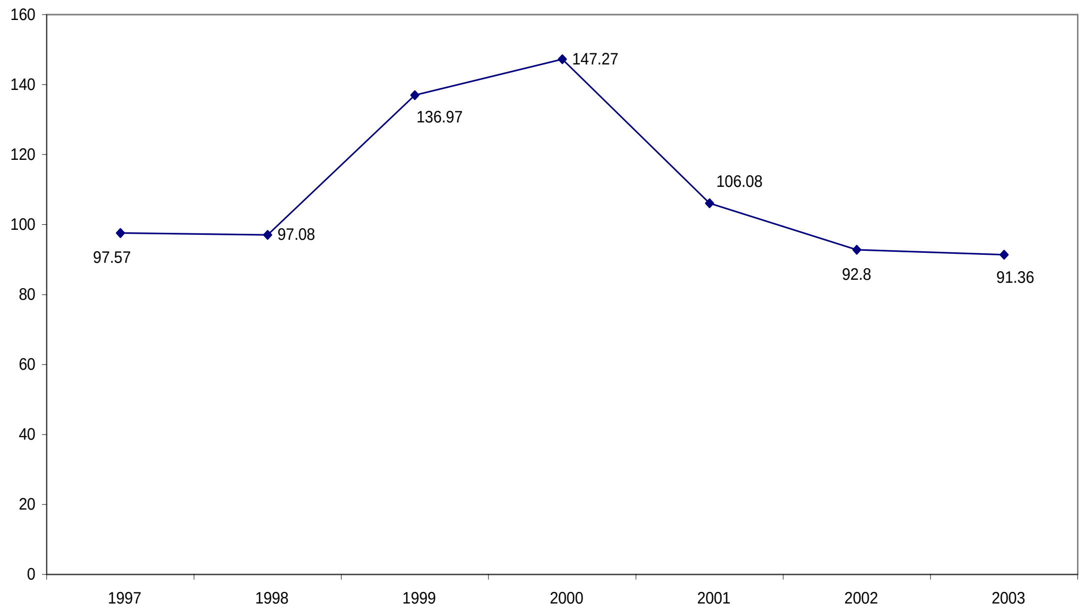
Source: Central Bank of Ecuador.

Figure 2
Ecuador: Trade Balance
1995-2004



Source: Central Bank of Ecuador.

Figure 3
Ecuador: Real Exchange Rate (effective). (1994=100)
1997-2003



Source: Central Bank of Ecuador. Statistical bulletin 1850, April 2006.

Table 1
Summary Statistics
1997 - 2003

Variable	Mean	S.D.	Median
Total production	4512615	12800000	748932
Labor	99	171	41
Capital	2342822	5821817	345101
Investment	202883	1149995	8329
Raw materials	2177732	6793255	317819
Value Added	2334883	7861637	383918

Source: INEC and author's construction.
Note: Total observations, 5047 establishments of the manufacturing industry in Ecuador. Quantitites in US dollars of 2000. Labor is number of employees.

Table 2
Trade Orientation by 4-digit ISIC codes
Averages 1997 - 2003

Industry (ISIC r.3)	Description	Export/ Output ratio	Import /Output ratio	Import Penetration	Trade Orientation
1511	Production, processing and preserving of meat and meat products	0.10	0.14	0.13	NT
1512	Processing and preserving of fish and fish products	1.26	0.03	-0.13	X
1513	Processing and preserving of fruit and vegetables	1.87	0.26	-0.53	X
1514	Manufacture of vegetable and animal oils and fats	0.13	0.41	0.32	M
1520	Manufacture of dairy products	0.01	0.05	0.04	NT
1531	Manufacture of grain mill products	0.13	0.05	0.05	NT
1532	Manufacture of starches and starch products	0.34	9.13	0.90	M
1533	Manufacture of prepared animal feeds	0.02	0.14	0.13	NT
1541	Manufacture of bakery products	0.04	0.18	0.16	NT
1542	Manufacture of sugar	0.09	0.19	0.13	NT
1543	Manufacture of cocoa, chocolate and sugar confectionery	0.68	0.23	0.43	X
1544	Manuf. of macaroni, noodles, couscous and similar farinaceous products	0.01	0.04	0.04	NT
1549	Manufacture of other food products n.e.c.	0.41	0.64	0.51	X
1551	Distilling, rectifying and blending of spirits; ethyl alcohol prod- from fermented mat.	0.18	0.21	0.20	NT
1552	Manufacture of wines	0.04	11.15	0.92	M
1553	Manufacture of malt liquors and malt	0.00	0.06	0.05	NT
1554	Manufacture of soft drinks; production of mineral waters	0.02	0.11	0.09	NT
1600	Manufacture of tobacco products	0.03	0.02	0.02	NT
1711	Preparation and spinning of textile fibres; weaving of textiles	0.10	0.26	0.23	M
1721	Manufacture of made-up textile articles, except apparel	0.46	0.30	0.35	X
1722	Manufacture of carpets and rugs	0.01	1.78	0.63	M
1723	Manufacture of cordage, rope, twine and netting	0.40	7.80	0.93	M
1729	Manufacture of other textiles n.e.c.	1.30	30.50	0.99	M
1730	Manufacture of knitted and crocheted fabrics and articles	0.33	0.50	0.41	M
1810	Manufacture of wearing apparel, except fur apparel	0.32	0.60	0.46	M
1911	Tanning and dressing of leather	0.11	0.12	0.12	NT
1920	Manufacture of footwear	0.18	0.70	0.45	M
2010	Sawmilling and planing of wood	1.27	0.03	-0.28	X
2021	Manuf. of veneer sheets;plywood, laminboard, particle board & other panels & boards	0.52	0.05	0.09	X
2022	Manufacture of builders' carpentry and joinery	0.23	0.14	0.15	NT
2023	Manufacture of wooden containers	3.23	0.81	-0.17	X
2029	Manuf. of other wood prod.; manuf. of cork articles, straw and plaiting materials	6.88	2.98	0.15	X

Source: Trade data: Trade Statistics of the Central Bank of Ecuador. Total output: INEC and author's construction.
Note: X= export oriented, M= import competing, NT = nontradable.

Table 2 (cont'd)
Trade Orientation by 4-digit ISIC codes
Averages 1997 - 2003

Industry (ISIC r.3)	Description	Export/Output ratio	Import/Output ratio	Import Penetration	Trade Orientation
2101	Manufacture of pulp, paper and paperboard	0.14	2.46	0.70	M
2102	Manuf. of corrugated paper and paperboard & of containers of paper & paperboard	0.01	0.01	0.01	NT
2109	Manufacture of other articles of paper and paperboard	0.05	0.32	0.25	M
2211	Publishing of books, brochures, musical books and other publications	1.86	26.41	1.02	X
2212	Publishing of newspapers, journals and periodicals	0.00	0.05	0.05	NT
2219	Other publishing	4.21	63.85	1.06	M
2221	Printing	0.05	0.25	0.21	M
2222	Service activities related to printing	0.00	0.13	0.11	NT
2411	Manufacture of basic chemicals, except fertilizers and nitrogen compounds	3.01	13.62	1.18	M
2412	Manufacture of fertilizers and nitrogen compounds	0.01	1.76	0.64	M
2413	Manufacture of plastics in primary forms and of synthetic rubber	0.18	9.34	0.92	M
2421	Manufacture of pesticides and other agro-chemical products	1.41	92.64	1.00	M
2422	Manufacture of paints, varnishes and similar coatings, printing ink and mastics	0.02	0.30	0.24	M
2423	Manufacture of pharmaceuticals, medicinal chemicals and botanical products	0.35	2.46	0.78	M
2424	Manuf. of soap & detergents, cleaning & polishing and perfumes & toilet preparations	0.14	0.61	0.40	M
2429	Manufacture of other chemical products n.e.c.	0.40	5.87	0.90	M
2430	Manufacture of man-made fibres	7.87	74.64	1.10	M
2511	Manuf. of rubber tyres and tubes; retreading and rebuilding of rubber tyres	0.29	0.71	0.49	M
2519	Manufacture of other rubber products	0.03	8.25	0.89	M
2520	Manufacture of plastics products	0.13	0.48	0.35	M
2610	Manufacture of glass and glass products	0.23	1.25	0.62	M
2691	Manufacture of non-structural non-refractory ceramic ware	1.06	0.75	2.82	M
2692	Manufacture of refractory ceramic products	0.11	23.54	0.96	M
2693	Manufacture of structural non-refractory clay and ceramic products	0.07	0.26	0.21	M
2694	Manufacture of cement, lime and plaster	0.01	0.03	0.03	NT
2695	Manufacture of articles of concrete, cement and plaster	0.02	0.14	0.12	NT
2696	Cutting, shaping and finishing of stone	0.56	2.42	0.83	M
2699	Manufacture of other non-metallic mineral products n.e.c.	0.12	3.75	0.81	M
2710	Manufacture of basic iron and steel	0.05	1.57	0.61	M
2720	Manufacture of basic precious and non-ferrous metals	0.80	1.43	0.97	M
2811	Manufacture of structural metal products	0.06	0.67	0.39	M
2812	Manufacture of tanks, reservoirs and containers of metal	0.17	0.60	0.41	M

Source: Trade data: Trade Statistics of the Central Bank of Ecuador. Total output: INEC and author's construction.
Note: X= export oriented, M= import competing, NT = nontradable.

Table 2 (end)
Trade Orientation by 4-digit ISIC codes
Averages 1997 - 2003

Industry (ISIC r.3)	Description	Export/ Output ratio	Import/ Output ratio	Import Penetration	Trade Orientation
2893	Manufacture of cutlery, hand tools and general hardware	0.51	25.13	0.98	M
2899	Manufacture of other fabricated metal products n.e.c.	0.08	0.43	0.32	M
2911	Manuf. of engines and turbines, except aircraft, vehicle and cycle engines	5.80	99.00	1.08	M
2912	Manufacture of pumps, compressors, taps and valves	0.25	7.95	0.91	M
2914	Manufacture of ovens, furnaces and furnace burners	0.09	4.75	0.81	M
2919	Manufacture of other general purpose machinery	0.27	18.67	0.96	M
2922	Manufacture of machine-tools	16.58	448.93	1.03	M
2924	Manufacture of machinery for mining, quarrying and construction	59.80	398.62	1.20	M
2925	Manufacture of machinery for food, beverage and tobacco processing	2.29	121.88	1.01	M
2930	Manufacture of domestic appliances n.e.c.	0.20	0.55	0.40	M
3110	Manufacture of electric motors, generators and transformers	0.19	16.73	0.95	M
3120	Manufacture of electricity distribution and control apparatus	0.03	5.02	0.83	M
3130	Manufacture of insulated wire and cable	0.29	1.00	0.55	M
3140	Manufacture of accumulators, primary cells and primary batteries	0.11	2.05	0.69	M
3150	Manufacture of electric lamps and lighting equipment	0.30	3.03	0.79	M
3190	Manufacture of other electrical equipment n.e.c.	2.70	186.27	1.00	M
3230	Manuf. of tv and radio receivers, sound or video rec. or reprod. Apparatus	4.09	515.39	1.00	M
3311	Manufacture of medical and surgical equipment and orthopaedic appliances	0.31	47.38	0.98	M
3312	Manufacture of instruments and appliances	3.15	345.62	1.00	M
3410	Manufacture of motor vehicles	0.28	1.67	0.69	M
3420	Manuf. of bodies (coachwork) for mtv; manuf. of trailers and semi-trailers	0.02	0.94	0.48	M
3430	Manufacture of parts and accessories for motor vehicles and their engines	0.12	7.74	0.90	M
3511	Building and repairing of ships	0.97	4.38	0.57	M
3591	Manufacture of motorcycles	0.01	3.65	0.79	M
3599	Manufacture of other transport equipment n.e.c.	0.02	1.23	0.55	M
3610	Manufacture of furniture	0.05	0.19	0.16	NT
3691	Manufacture of jewellery and related articles	0.90	0.27	-0.40	X
3693	Manufacture of sports goods	0.81	144.95	1.00	M
3694	Manufacture of games and toys	0.74	8.30	0.97	M
3699	Other manufacturing n.e.c.	0.98	2.34	1.01	M

Source: Trade data: Trade Statistics of the Central Bank of Ecuador. Total output: INEC and author's construction.
Note: X= export oriented, M= import competing, NT = nontradable.

Table 3
Trade Orientation by 2-digit ISIC codes
Averages 1997 - 2003

Industry (ISIC r.3)	Description	Export/Output ratio	Import/Output ratio	Import Penetration	Trade Orientation
15	Manufacture of food products and beverages	0.49	0.13	0.2	X
16	Manufacture of tobacco products	0.03	0.02	0.02	NT
17	Manufacture of textiles	0.17	0.43	0.34	M
18	Manufacture of wearing apparel; dressing and dyeing of fur	0.32	0.6	0.46	M
19	Tanning and dressing of leather; manufacture of luggage, handbags, saddlery, harness and footwear	0.18	0.73	0.46	M
20	Manuf. of wood and wood prod.&cork prod., excpt. furniture; manuf. of straw articles & plaiting materials	0.66	0.07	0.16	X
21	Manufacture of paper and paper products	0.03	0.28	0.23	M
22	Publishing, printing and reproduction of recorded media	0.04	0.56	0.37	M
24	Manufacture of chemicals and chemical products	0.29	2.6	0.78	M
25	Manufacture of rubber and plastics products	0.17	0.62	0.43	M
26	Manufacture of other non-metallic mineral products	0.08	0.25	0.22	M
27	Manufacture of basic metals	0.17	1.54	0.64	M
28	Manufacture of fabricated metal products, except machinery and equipment	0.08	0.73	0.44	M
29	Manufacture of machinery and equipment n.e.c.	0.32	5.22	0.88	M
31	Manufacture of electrical machinery and apparatus n.e.c.	0.22	3.74	0.83	M
33	Manufacture of medical, precision and optical instruments, watches and clocks	0.6	84.29	0.99	M
34	Manufacture of motor vehicles, trailers and semi-trailers	0.27	1.94	0.72	M
35	Manufacture of other transport equipment	0.95	6.74	1.18	M
36	Manufacture of furniture; manufacturing n.e.c.	0.23	0.82	0.51	M

Source: Trade data: Trade Statistics of the Central Bank of Ecuador. Total output: INEC and author's construction.
Note: X= export oriented, M= import competing, NT = nontradable.

Table 4
Estimates of Production Functions by industry
Balanced Panel data
Averages 1997 – 2003

INDUSTRY	Coefficient	OLS Coefficient		OLS S.E.	(1) Fixed Effects (IV) Coefficient		(1) Fixed Effects (IV) S.E.	(2) Difference GMM Coefficient		(2) Difference GMM S.E.
1 Food Processing	Labor	0.844	*	0.031	0.771	*	0.160	0.191	*	0.062
	Capital	0.424	*	0.017	0.117	**	0.067	-0.032		0.089
	Constant	4.137	*	0.149	8.525	*	1.044	0.157	*	0.065
	N	1183			1014			855		
	Adj. R^2 (overall R^2)	0.84			0.81					
2 Textiles	Labor	0.494	*	0.039	0.305	*	0.109	0.268	*	0.070
	Capital	0.506	*	0.023	0.146	*	0.061	-0.048	**	0.009
	Constant	4.432	*	0.229	9.949	*	0.833	0.183	*	0.093
	N	462			396			330		
	Adj. R^2 (overall R^2)	0.82			0.78					
3 Apparel and Leather	Labor	1.063	*	0.044	0.988	*	0.271	0.665	*	0.104
	Capital	0.249	*	0.025	0.009		0.888	-0.084		0.102
	Constant	5.212	*	0.204	8.292	*	1.080	0.192	*	0.089
	N	511			438			369		
	Adj. R^2 (overall R^2)	0.81			0.79					
4 Wood and Paper	Labor	0.638	*	0.041	0.669	*	0.188	-0.024		0.072
	Capital	0.499	*	0.019	0.146	*	0.059	0.208	*	0.089
	Constant	4.067	*	0.135	8.304	*	0.938	0.217	*	0.059
	N	679			582			485.00		
	Adj. R^2 (overall R^2)	0.91			0.88					
5 Chemicals, Rubber, Plastics, and Nonmetalic products	Labor	0.820	*	0.035	0.599	*	0.150	0.177	*	0.059
	Capital	0.424	*	0.018	0.037		0.058	-0.058		0.069
	Constant	4.563	*	0.165	10.354	*	0.715	0.192	*	0.054
	N	1106			948			790		
	Adj. R^2 (overall R^2)	0.80			0.73					
6 Basic metals and metal products	Labor	0.800	*	0.065	0.457	**	0.279	0.165		0.164
	Capital	0.437	*	0.037	0.044		0.080	-0.026		0.104
	Constant	4.551	*	0.285	10.882	*	1.311	0.221	**	0.131
	N	329			282			235		
	Adj. R^2 (overall R^2)	0.88			0.835					
7 Machinery, equipment and vehicles	Labor	0.873	*	0.053	0.748	*	0.211	0.497	*	0.100
	Capital	0.463	*	0.031	0.364	*	0.109	0.097		0.149
	Constant	3.739	*	0.259	5.510		1.632	0.138		0.103
	N	371			318			269		
	Adj. R^2 (overall R^2)	0.86			0.86	*				
8 Furniture	Labor	0.929	*	0.066	0.650	*	0.179	0.447	*	0.093
	Capital	0.414	*	0.034	0.080		0.081	-0.179	**	0.104
	Constant	4.007	*	0.287	9.060	*	1.231	0.278	*	0.094
	N	357			306			255		
	Adj. R^2 (overall R^2)	0.77			0.73					

Notes:
* Significant at 5 percent
** Significant at 10 percent

Table 5
Estimates of Production Functions by trade orientation
Balanced Panel data
Averages 1997 – 2003

INDUSTRY		Factor	(Benchmark) Ordinary Least Squares (OLS) Coefficient		S.E.	Fixed Effects (IV) Coefficient		S.E.
1	**Export oriented**	Labor	0.706	*	0.041	0.881	*	0.186
		Capital	0.411	*	0.023	0.129		0.101
		1998	0.106		0.111	-0.055		0.081
		1999	0.139		0.111	--		--
		2000	0.157		0.111	0.016		0.081
		2001	0.095		0.111	-0.050		0.081
		2002	-0.007		0.111	-0.156	*	0.083
		2003	-0.084		0.111	-0.226	*	0.082
		Constant	4.775	*	0.212	7.951	*	1.556
		N	651			558		
		Adj. R^2 (overall R^2)	0.83			0.79		
2	**Import competing**	Labor	0.741	*	0.019	0.571	*	0.083
		Capital	0.453	*	0.010	0.071	*	0.031
		1998	0.006		0.050	-0.222	*	0.026
		1999	0.012		0.050	-0.224	*	0.026
		2000	0.217	*	0.050	--		--
		2001	0.286	*	0.050	0.076	*	0.026
		2002	0.205	*	0.050	0.015		0.026
		2003	0.115	*	0.050	-0.081	*	0.026
		Constant	4.226	*	0.094	9.968	*	0.427
		N	2905			2490		
		Adj. R^2 (overall R^2)	0.83			0.77		
3	**Non tradable**	Labor	0.908	*	0.029	0.636	*	0.115
		Capital	0.449	*	0.014	0.413	*	0.045
		1998	-0.020		0.071	-0.169	*	0.037
		1999	-0.070		0.071	-0.229	*	0.038
		2000	0.039		0.071	-0.108	*	0.038
		2001	0.175	*	0.071	0.037		0.037
		2002	0.170	*	0.071	0.061	**	0.037
		2003	0.114		0.071	--		--
		Constant	3.577	*	0.119	8.655	*	0.693
		N	1449			1242		
		Adj. R^2 (overall R^2)	0.88			0.86		

Notes:
* Significant at 5 percent
** Significant at 10 percent

Table 6.- Aggregate Productivity Index, by industry

Year	Aggregate Productivity effect	Own-plant effect	"Reshuffling" effect	Aggregate Productivity Index
1. Food processing				
1997	1.1528	0.0000	1.1528	100
1998	1.8159	0.1313	1.6840	158
1999	1.7388	0.1238	1.6145	151
2000	1.5800	0.1305	1.4494	137
2001	1.4819	0.1447	1.3363	129
2002	1.5159	0.1344	1.3814	131
2003	1.4624	0.1306	1.3308	127
2. Textiles				
1997	0.9493	0.0000	0.9493	100
1998	1.0138	-0.0450	1.0587	107
1999	1.0174	-0.0450	1.0623	107
2000	0.9634	-0.0450	1.0083	101
2001	0.8497	-0.0450	0.8947	90
2002	0.8795	-0.0450	0.9245	93
2003	0.8861	-0.0450	0.9311	93
3. Apparel and Leather				
1997	0.8173	0.0000	0.8173	100
1998	0.8470	0.0985	0.7485	104
1999	0.8466	0.0943	0.7523	104
2000	0.8013	0.0960	0.7053	98
2001	0.9352	0.1036	0.8315	114
2002	0.8673	0.1021	0.7651	106
2003	0.9386	0.0995	0.8377	115
4. Wood and Paper				
1997	1.2646	0.0000	1.2646	100
1998	1.2960	0.0334	1.2626	102
1999	1.6919	0.0334	1.6585	134
2000	1.1252	0.0334	1.0918	89
2001	1.1938	0.0334	1.1604	94
2002	1.0232	0.0334	0.9899	81
2003	1.1965	0.0334	1.1631	95
5. Chemicals, Rubber, Plastics, and Nonmetallic prod.				
1997	1.7987	0.0000	1.7987	100
1998	1.8190	-0.0138	1.8328	101
1999	1.9541	-0.0138	1.9679	109
2000	1.9419	-0.0138	1.9557	108
2001	1.7545	-0.0138	1.7683	98
2002	1.7136	-0.0138	1.7274	95
2003	1.7312	-0.0138	1.7450	96
6. Basic metals and metal products				
1997	2.1878	0.0000	2.1878	100
1998	1.9572	0.0377	1.9195	89
1999	1.9410	0.0377	1.9033	89
2000	2.0775	0.0377	2.0398	95
2001	1.7627	0.0377	1.7250	81
2002	1.5666	0.0377	1.5288	72
2003	1.5855	0.0377	1.5478	72
7. Machinery, equipment, and vehicles				
1997	1.1126	0.0000	1.1126	100
1998	1.3217	0.1525	1.1693	119
1999	0.9400	0.1793	0.7607	84
2000	1.1832	0.1578	1.0253	106
2001	1.4411	0.1536	1.2875	130
2002	1.1366	0.1545	0.9821	102
2003	0.9974	0.1625	0.8319	90
8. Furniture				
1997	1.6305	0.0000	1.6305	100
1998	1.9835	0.2621	1.7213	122
1999	2.1391	0.2621	1.8770	131
2000	2.0390	0.2621	1.7769	125
2001	1.8963	0.2621	1.6341	116
2002	1.7673	0.2621	1.5051	108
2003	1.7642	0.2621	1.5020	108

Table 7
Aggregate Productivity Index by trade orientation

Year	Aggregate Productivity effect	Own-plant effect	"Reshuffling" effect	Aggregate Productivity Index
1. Import-competing				
1997	1.7947	0.0000	1.7947	100
1998	2.0452	0.2342	1.8111	114
1999	1.9544	0.2372	1.7171	109
2000	1.9977	0.2341	1.7636	111
2001	2.0055	0.2338	1.7717	112
2002	1.8816	0.2339	1.6477	105
2003	1.9246	0.2350	1.6891	107
2. Nontradable				
1997	1.7103	0.0000	1.7103	100
1998	2.3398	0.1824	2.1574	137
1999	2.4035	0.1767	2.2262	141
2000	2.0852	0.1779	1.9073	122
2001	2.0643	0.1906	1.8728	121
2002	2.1318	0.1795	1.9523	125
2003	2.1397	0.1846	1.9542	125
3. Export-oriented				
1997	0.6742	0.0000	0.6742	100
1998	1.0564	0.1693	0.8856	157
1999	1.1144	0.1628	0.9516	165
2000	1.0659	0.1769	0.8890	158
2001	0.6900	0.1781	0.5119	102
2002	0.4979	0.1825	0.3154	74
2003	0.4297	0.1680	0.2596	64

Table 8
Estimates of Trade Regressions using productivity estimates from Fixed effects-IV estimators
Balanced Panel data
1997 - 2003

	Trade orientation OLS			Trade orientation Fixed effects			RER effects OLS			Effective rate of protection OLS		
COEFFICIENT	**Coefficient**		**S.E.**	**Coefficient**		**S.E.**	**Coefficient**		**S.E.**	**Coefficient**		**S.E.**
dtradeX	0.162	*	0.064	--		--	0.550		1.371	--		--
dtradeM	-0.019		0.052	--		--	0.291		0.941	--		--
d99-00	0		0.056	0.007		0.028	0.088		0.229	--		--
d01-03	0.07	**	0.038	0.109	*	0.025	0.104		0.070	--		--
itx9900	--		--	0.069		0.050	-0.057		0.407	--		--
itx0103	-0.24	*	0.092	-0.242	*	0.046	-0.234	**	0.124	--		--
itm9900	0.056		0.069	0.034		0.034	-0.062		0.280	--		--
itm0103	--		--	-0.070	*	0.031	-0.068		0.085	--		--
constant	0.07		0.044	0.036	*	0.011	-0.238		0.769	0.084		0.105
RER							0.002		0.005	-0.0002		0.001
itxRER							-0.003		0.009	--		--
itmRER							-0.002		0.006	--		--
dERP_high										0.129	*	0.038
dERP_low										0.185	*	0.047
mpenetration										-0.049	**	0.029
N	5032			5032			5010			5010		
Adj. R2	0.004			0.001			0.001			0.007		

Notes:
* Significant at 5 percent
** Significant at 10 percent
Excluded categories are trade orientation dummy variable for nontradables, time dummy for years 1997-98.