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Productivity growth in Latin American manufacturing: what role for international trade intensities?

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Abstract

This paper analyzes the relationship between the intensity of international trade flows and labor productivity for 28 industries in the five main economies in the region (Argentina, Brazil, Chile, Colombia and Mexico) using the Arellano-Bond generalized method of moments (GMM) estimator. The results show that international trade flows contributed through various channels to labor productivity growth in the period 1990 to 2008. These channels, which have been developed in the theoretical literature, are export intensity (share of production exported), import penetration (share of domestic demand covered by imports), the diversification of the export basket and intra-industry trade. The estimation also includes several control variables, of which several turn out significant. In addition to estimates for the total manufacturing sector, we also show results for three different groups of manufacturing industries characterized by different factor endowments: natural resource intensive, labor and capital intensive ones.

Introduction

To better understand the dynamics of emerging economies, many studies focus on the manufacturing sector and its performance as measured by productivity growth. The attention on this sector stems from its unique characteristics in terms of the locus within the economy of the process of research and development (R&D), the forward and backward linkages to other sectors of the economy, the potential for scale economies and productivity increases and links with the global economy as part of global value and production chains. This potential had led several economists to place manufacturing at the heart of a country's development process, including Kaldor, Hirschman, Kalecki, Prebisch, Pasinetti and Thirwall.

At the beginning of the second decade of the twentieth century, there is a renewed interest in Latin America in evaluating the performance of manufacturing in part because of the premature deindustrialization process that is taking place in many Latin American countries. This process is most visible in GDP and exports, as evidenced in the case of the former variable by a drop from 22 to 17 percent between 1992 and 2009 (World Bank, World Development Indicators 2011). In some countries like Argentina and Brazil, this deindustrialization process is occurring at a particularly fast rate, and is explained in part by the Dutch disease phenomenon. This refers to the countries' boom in commodity exports that puts a downward pressure on the exchange rate and renders non-commodity exports in part non-competitive, in particular against those from Asia and China. In this context, both Mercosur countries have adopted measures to protect and reinvigorate their manufacturing sector.

Even though manufacturing is the sector with the greatest potential for productivity growth, various studies have illustrated that productivity

levels and growth rates differ widely not only among countries but also among individual industries. For example, labor productivity grew most rapidly in the knowledge-intensive industries in the major economies of the region from 1990 to 2003, followed by labor intensive industries and natural-resource intensive industries (ECLAC, 2007, p.62). This result is not surprising given that the first group of industries is most intensive in R&D and human capital.

To understand the productivity dynamics of manufacturing in the past two decades, it is fundamental to take into account the changing context in terms of the opening of the economies and increasing trade flows. There are at least three channels by which increased import and export flows should raise productivity. First, as firms are exposed to competition both in their home market and abroad, they are forced to upgrade their products and productive processes to survive in the market, thus reducing their gap with those firms that are on the technological frontier. In the literature, this effect is known as the disciplinary effect of imports. The second channel is the inputs and capital goods coming from abroad which are used in the domestic production of final goods. Domestic firms adopt new processes or optimize the existing ones by integrating new technologies, impacting productivity at a firm level. The third channel refers to technology transfers to local firms through foreign direct investment, which produce positive externalities in the domestic economy.

Within the evaluation of the links between trade and productivity, this paper examines the role of trade intensities in labor productivity growth in manufacturing in the five main economies in the region. In particular, the objective is to analyze the roles of import penetration, export intensity and diversification and intra-industry trade on productivity in the period 1990 to 2008.

The next section briefly outlines the main trends in productivity growth, while the second section provides an overview of previous empirical work in this area. The third discusses the econometric model, the variables used and data sources. Finally, we present the estimation results, followed by some conclusions and possible extensions of this research.

I.   Labor productivity performance in Latin American manufacturing

From 1990 to 2008, labor productivity in manufacturing in the five main Latin American economies grew 2.7 per cent on average per year. Except for Mexico, labor productivity increased at a faster rate in the 1990s than in the 2000s, which is relatively surprising as overall GDP expanded at a faster rate in the latter instead of the former decade. Overall, productivity grew most in Argentina, followed by Chile, Mexico, Colombia and finally Brazil (see Table 1). The result in the latter country is associated with a massive reduction of the share of manufacturing in GDP, and a much smaller decline of this sector in employment.

TABLE 1
SELECTED COUNTRIES: GROWTH OF LABOR PRODUCTIVITY IN MANUFACTURING, 1990 TO 2008
(Annual average growth rates %)

|	1990-1995	1996-2000	2001-2005	2006-2008
Argentina	7.8	2.6	4.8	1.1
Brazil	4.4	3.2	-2.2	-3.2
Chile	5.2	6.2	0.4	2.7
Colombia	-2.4	6.7	2.8	2.1
Mexico	3.1	0.9	2.9	5.1

Source: Authors' calculations based on the PADI database.

With regard to sectors, productivity grew fastest in engineering-intensive sectors (3.6% per year on average from 1990 to 2008), followed by natural resources based industries (2%) and labor-intensive ones (2%). However, in the first half of the 2000s productivity growth slowed down substantially in all sectors.

The increase in labor productivity is partly related to the pressure and opportunities that arose from the trade and financial reforms that took place from the 1980s onwards. Two phases of structural reforms reduced import barriers and relaxed the control on domestic financial markets. The first wave of reforms was during the 1980s, and the second during the first half of the 1990s (see reform index in Figure 1). Nevertheless, after 1995 the financial liberalization index experienced slight drop, as new financial regulation restricted access to credit. Nevertheless, the trade opening index has not only maintained its level since the second half of the 1990s, it showed further declines in protection in the 2000s following the adoption of several bilateral trade agreements.

Trade liberalization increases the demand of imports of goods and services, as well as the volume of exports. Imports increase competition in the domestic market and allow for the use of better quality and more technologically advanced imported inputs in the production of exports. Both have a positive impact on productivity. In parallel, financial market reform is crucial to facilitate the financing of investments in capital and R&D.

FIGURE 1
REFORM AND LABOR PRODUCTIVITY INDICES, 1990-2007
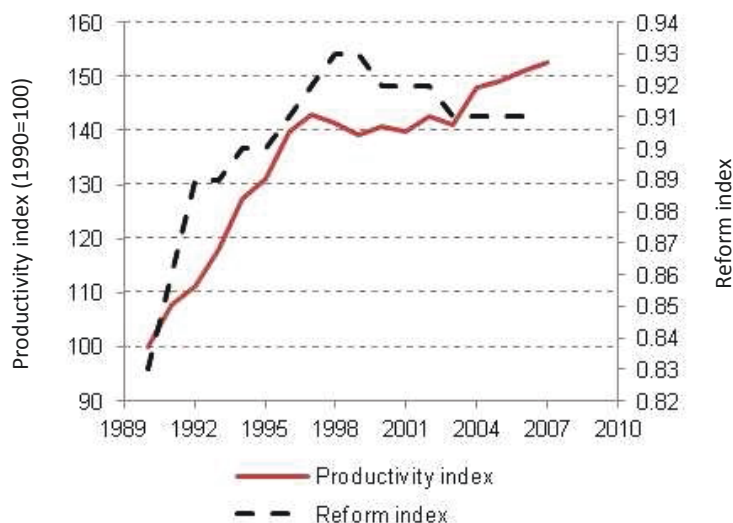
Source: PADI; Authors' calculations based on Morley et. al. (1999).

For the five countries together, natural-resources based manufacturing was the predominant subgroup, representing around 47% of total manufacturing value added in 2008, followed by engineering-intensive industries (35%) and labor-intensive sectors (18%). Within this set of countries, Mexico was an exception as engineering-intensive industries represented 43 per cent of total manufacturing value added.

From 1990 to 2008, the main changes within the production structure were the increase in the share of engineering intensive industries and the decline in labor intensive industries, while the shares of natural intensive industries remained more or less constant. These trends are most clear in Brazil and Mexico, where electrical and non electrical machinery in the former country and transport equipment in the latter were the most prominent winners. The labor-intensive industries that most have reduced their participation were textiles and wearing apparel (see Annex 1).

II. Trade and productivity in Latin America: a literature review

In the theoretical literature, there is a controversy on the long-run relation between trade policies and economic growth. The traditional neoclassical growth theory claims that trade does not affect the steady state, as technological progress is exogenous (Solow, 1957). In contrast, the new growth and trade theories show that trade openness facilitates the entrance of imports embodying new technologies which in turn improve productivity and increase growth (Grossman and Helpman, 1992). The effect of trade openness on productivity depends in part on the speed at which resources can move from industries with low to the ones with higher productivity levels and improve the aggregate productivity in the economy (Redding, 2002).

Several recent studies abandoned classic assumptions of perfect competition to identify the transmission channels between trade and productivity. For example, Tybout et al. (1991), Ferreira (2003) and Paus (2003)) include proxies of industrial concentration and increasing returns to scale. Krugman (1981) proposes the theory of the intra-industry trade to explain productivity growth under the assumption of monopolistic competence with heterogeneous goods. If the country of destiny is similar in endowments to the country of origin, then intra industrial trade will arise and economies of scale are essential.

A. Three general transmission channels

Most traditional studies in this area use industry-level (meso) data to analyze the effects of openness and trade on productivity of manufacturing considering variables such as international trade flows (exports and

imports by industry), openness indicators, industrial concentration and other macroeconomic variables as inflation and public expenses. Most studies focus on labor productivity as the dependent variable, although some use multi factor productivity (MFP).

This literature distinguishes three channels by which international trade affects productivity. First, imports expose domestic firms to competition, which forces them to raise their productivity to survive in the market. Paus et al. (2002) show, for a group of Latin-American countries over the period 1970-1998, that international trade –as proxied by by export intensity, import penetration and a reform index-, increases productivity growth of manufacturing firms.

Second, imported inputs and capital goods allow firms to optimize their processes and incorporate new technologies, which in turn raises their productivity. Sjoeholm (1999) shows that if foreign technologies are more efficient than those available in the domestic market, imported capital goods and inputs raise labor productivity. Eaton and Kortum (2001) attribute 25% of cross-country productivity differences to the variation in the relative prices of equipment, about half of which they ascribe to barriers to trade in equipment. A lower rate of productivity growth (12%) is associated to trade barriers of capital goods that hinder the diffusion of technological progress. Ferreira and Rossi (2001) find significant evidence on the positive effect of international trade on productivity growth for Brazil over the period preceding and following its trade liberalization in 1988-90. There were large productivity improvements across industries after trade barriers were drastically reduced (6% increase in multi factor productivity growth). Schiff, Wang and Olarreaga (2002) find that North-South and South-South R&D spillovers have a positive impact on total factor productivity. North-South spillovers raise productivity in R&D intensive industries while South-South raises the performance in low R&D-intensity industries (R&D intensive learning from the North and low R&D-intensity industries take advantage from trading with the South). These findings suggest the need to incorporate variables that capture the capital supply effect and the absorption of new technologies following trade liberalization.

The third channel by which international trade impacts productivity is the use of new technologies through direct foreign investment (FDI). Empirical studies are not conclusive in this respect, in part because there is an endogeneity problem among productivity growth and exports. For example, Aw et al. (1997) confirm, for the case of electronic products in Taiwan, that exports produce externalities that impact positively on productivity. In contrast, Haddad et al. (1996) and Aswicahyono at al. (1996) conclude that only domestic firms that are productive before exporting succeed in expanding toward foreign markets. Rodrick (1988) and Bhagwati (1988) agree that there is not enough evidence of economies of scale in developing countries.

When trade is accompanied by FDI, the transfer of knowledge and learning-by-exporting process is reinforced (Nordas et al., 2006). Wacziarg (1998) argues that a plant that wants to export needs to invest, which increases in turn its productivity. This happens only if there are well developed financial markets and R&D efforts (Basant and Fikkert, 1996). FDI has the potential to increase productivity by incorporating new firms using state of the art technologies, although the magnitude of this effect depends on the availability of skilled human capital which in turn determined the capacity of domestic firms to adopt new technologies.

The reviewed studies use a variety of methodologies are used to estimate productivity: dynamic panels (Paus et al., 2003), static panels (Ferreira et al., 2003; Paus et al., 2003), Spearman´s correlation (Tybout et al., 1991) and the Olley and Pakes´s Algorithm (López-Córdova, 2002; Aw, 2005).

It should be kept in mind that even though several industry-level studies find a positive effect of trade on productivity, many have been unable to confirm this causality. This may be due to the fact that several industry level analysis have not adequately considered the "intensity" of the flows in terms of how much exports represent as a share of output and imports as a proportion of final demand (e.g. Paus et al., 2003). Also, few studies take into consideration the characteristics of exports and imports in terms of for example concentration and intra-industry trade. Moreover, other studies look into the causality for all industries without considering differences in endowments.

B.   Firm and plant dynamics

In the last decade, the empirical studies have been extended to firm level data to estimate production functions and multi-factor productivity and their relationship to trade. In contrast to industry-level studies, the micro studies are almost unanimous in confirming the link between trade and productivity and vice versa. Several micro-studies focus on specific industries (Tybout, 1991 et al.; Lopez-Cordova, 2002; Aw, 2005).

Micro level studies have emphasized the role of productivity increases due to the exit of less productive firms in industries that experience reductions in trade costs (Pages, 2010). For example in Brazil and Chile, studies show a reallocation of resources from non-exporting and less productive firms towards more productive exporting firms. Firms that exit are, on average, less productive than those surviving, and firms that export or begin exporting are generally more productive than those that only produce for the domestic market (firms that exit are, on average, 8% less productive in Brazil and 11% in Chile). Results of these studies show that firms in industries that experiment the largest reductions in trade costs are more susceptible to exit the market and have a higher probability of becoming exporters (decrease of 10 percentage points in trade costs increase probability of exit in 7% in Chile and 3% in Brazil and in 7% the probability of becoming an exporter in Chile).

Within this context, transport costs play a particularly important role in explaining productivity behavior (Pages, 2010). These costs are high in Latin America compared to other regions in the world, and represent a sizable proportion of total exporting cost, especially in natural resource intensive industries. For instance, a reduction of 10 percentage points in transport costs has a 0.7% positive impact in productivity in Chile and a 0.5% in Brazil. Marginal effects of a reduction of tariffs are more important in magnitude than the effect of a reduction in transport costs, but the margin of reduction is bigger for transports costs, thus it is essential to reduce them. A reduction of 10 percentage points in transport costs has also a significant effect on the probability of exit of less productive firms (probability of exit increases in 1.5% in Chile).

III. The empirical analysis

The empirical findings revised in the previous section can be extended in several ways, as is done in this paper. The most important contribution of this paper is the measurement of the trade channels not in terms of changes in obstacles to trade (e.g. through tariffs or transport costs) or absolute changes in trade flows, but through the "intensity" and "quality" of these flows. The latter are proxied by the ratio of exports to production, the penetration of imports in domestic demand, the diversification of exports and the intra-industry character of trade flows. These measures differ from those used in other studies, such as import tariffs (Edwards, 1998), trade liberalization index (Nash, 1992), and export and imports volumes (Upadhyay, 2000; Paus et al., 2003).

Second, it is important to consider the type of industries when analyzing the trade and productivity relationship. That is, each transmission channel may have a different relative importance in industries which are intensive in natural resources compared to sectors that are labor abundant or capital and R&D intensive. Each group of industries has different technologies, a different labor productivity growth potential, and different types of trading relations with the world. As argued in ECLAC's publication Progreso Técnico y Estructural en América Latina (2007) (Technical and Structural Progress in Latin America): "The structures, defined as the participation of the different sectors in the added value of the economy, impacts in the long-term economic performance. This is, in some sectors, the productivity tends to grow more than in other, then these they generate besides, technological externalities that benefit other activities and they contribute to elevate the aggregate productivity." The analysis should therefore integrate the structure of manufacturing sector. This paper follows Paus et al. (2003) in terms of groups of sectors.

A. Variables

The independent variable in this study is labor productivity, measured by the ratio of value added to persons engaged in manufacturing. Labor productivity is used here as a proxy of multi-factor productivity (MFP). The latter could not be estimated as for most countries no investment series by industry are available, which prevent the estimation of capital productivity and MFP. As labor and MFP are closely correlated, the measurement bias is probably small (Ferreira and Rossi, 2003).

Labor productivity growth is explained by several factors. Several have been used in the empirical literature, while some new ones related to international trade are also considered. Several variables correspond to observations at the industry-country level, while others are country specific.[1]

The following variables related to international trade "intensity" and "quality'" are used:

(a) Export intensity is the ratio of exports over production (industry and country specific) and shows the share of production exported. A higher ratio suggests a larger scale of production (compared to a situation without exports), which may increase labor productivity (hypothesis 3 of the literature review).

(b) Import penetration or external dependence (industry and country specific) is the ratio of imports to domestic demand. The latter equals production plus imports minus exports. This indicator illustrates how much of domestic demand is satisfied by imports. A higher import penetration suggests a higher competitive pressure on the domestic market and a push to raise productivity.

(c) Intra-industry trade index (Grubel and Lloyd) (country-industry specific) measures the degree to which exports and imports are part of the same industries. A high value of this indicator (close to 1) suggests a country´s trade is of an intra-industry type, indicating it participates actively in global value chains and benefits from technology transfers which may increases its productivity. In contrast, if a country exports and imports goods that belong to different industries, its trade is of an inter-industry type, and the value of the index approaches 0. In this case, its trade relations are more likely to be of an arm´s length type, with fewer possibilities of technology transfer.

(d) Export diversification (Herfindahl-Hirschman concentration index): a more diversified export basket, with an index takes approaching zero, will increase productivity as producing such a basket requires more skill-intensive workers.

(e) Trade and Financial Market Reform Index (country specific): this index measures the degree of trade and financial liberalization. First, a reduction of tariff and non-tariff barriers increases the competition of imports with domestically produced goods in the domestic market. Moreover, it facilitates the import of newer technologies through machines and intermediate inputs. Both increase labor productivity growth. Secondly, financial market reform facilitates access to credit, which in turn may boost investment and productivity.

Several other indicators refer to the structure of the industry:

(f) The Krugman Specialization Index (country-industry) shows the relative difference between industry compositions of the manufacturing sector in country j relative to that of the United States. The manufacturing sector of the latter country has one of the world´s most "mature" structures in terms of productivity levels and potential for productivity growth, as suggested by the high share of engineering-intensive industries in total manufacturing value added. The more dissimilar the production structures between country j and the United States, illustrated by a Krugman index approaching the value of 2, the lower the labor productivity growth potential of country A. Similar production structures, represented by a Krugman index approaching zero, raises the labor productivity growth potential of country j.

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[1]   For a more detailed description of the variables and data sources, see Annex 1.

(g) Industry concentration index, calculated by a Herfindahl Index based on the inverse of the number of firms by industry, assuming that each firm has the same market share. When an industry has only one or few firms, illustrated by an index close to 1, it is likely there are fewer pressures to increase productivity.

Finally, the analysis considers two other control variables:

(h) Productivity gap between industry i in country j and the same industry in the United States (industry-country specific): shows the distance between industry i in country j to the technological frontier as indicated by the United States. The larger the productivity gap, the bigger the "catch-up" bonus or space available to increase productivity. In general, countries with a larger gap show higher rates of productivity growth.

(i) Growth of US productivity (industry specific): a proxy of the movement of technologic frontier. A higher rate of US productivity growth within a particular industry suggests a faster moving technological frontier compared to other industries with a lower rate of productivity growth. As knowledge is diffused through international trade and foreign direct investment, it is likely that productivity will also increase faster in this industry in other countries.

B. Data sources

The sample of this paper refers to the five main Latin American economies (Argentina, Brazil, Chile, Colombia, and Mexico) for the period 1990 to 2008, complemented with the United States being one of the international productivity leaders. The variables included are the number of firms, gross output, value added, persons engaged, exports and imports. Using these variables, several indicators are constructed to characterize an industry in terms of the growth and level of labor productivity, its competitive pressures, export orientation and diversification, import penetration, participation in global value chains, and difference in industrial structure compared to the United States.[2] The data are broken down into twenty-eight industries according to the 3-digit International Standard Industrial Classification (ISIC Second Revision).

The data are drawn from the annual manufacturing surveys of the national institutes of statistics: INDEC in Argentina, IBGE in Brazil, INE in Chile, DANE in Colombia and INEGI in Mexico. These data are consolidated in a database called Program for the Analysis of Industrial Dynamics (Programa de Análisis de la Dinámica Industrial, PADI) constructed by the Division of Productivity, Production and Management of the Economic Commission for Latin America and Caribbean (ECLAC). The data only cover formally established firms and exclude informal activities. Production and value added figures at current prices were transformed into constant 1985 US$ series using industry deflators from the same sources and the exchange rate, complemented with ad hoc estimates developed by ECLAC. Export and import data in current and 1985 constant US$ are from the BADACEL database of ECLAC's Division of Statistics.
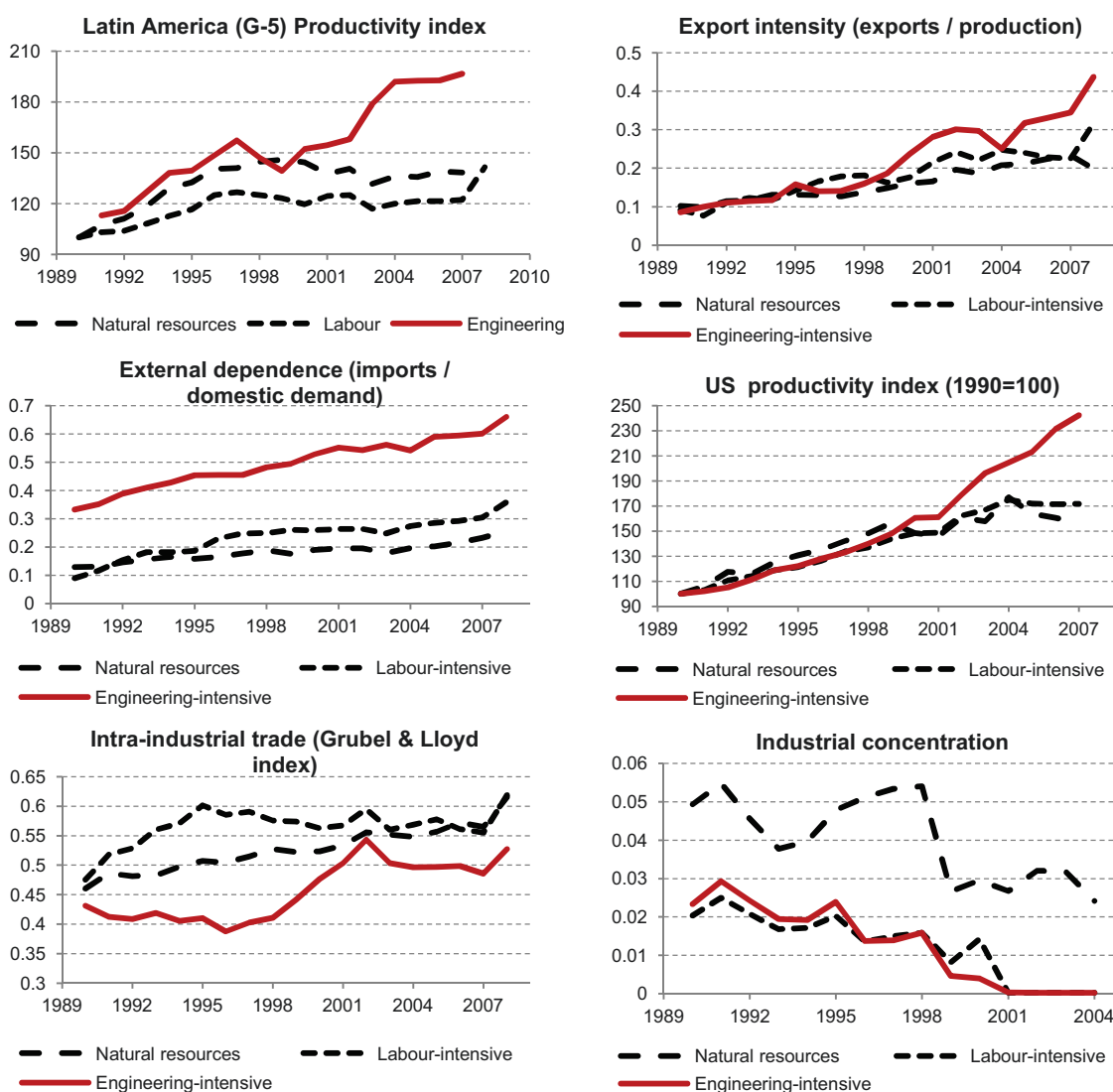
C. Main trends

In our sample of countries, labor productivity in the engineering intensive industries grew most in the past two decades. This finding is consistent with the type of endowments of this group of industries being most intensive in skilled labor, capital and innovation. Labor intensive industries are the group that registered the weakest performance, with labor productivity stagnating between 1995 and 2007. The intermediate position of natural resource intensive industries may be related to the export commodity boom in the 2000s (see Figure 2).

The superior performance of the engineering intensive industries is confirmed by its better scores on several —but not all— of the explanatory variables considered in this paper. These include export

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[2] For details on the construction of the variables, see Annex 1.

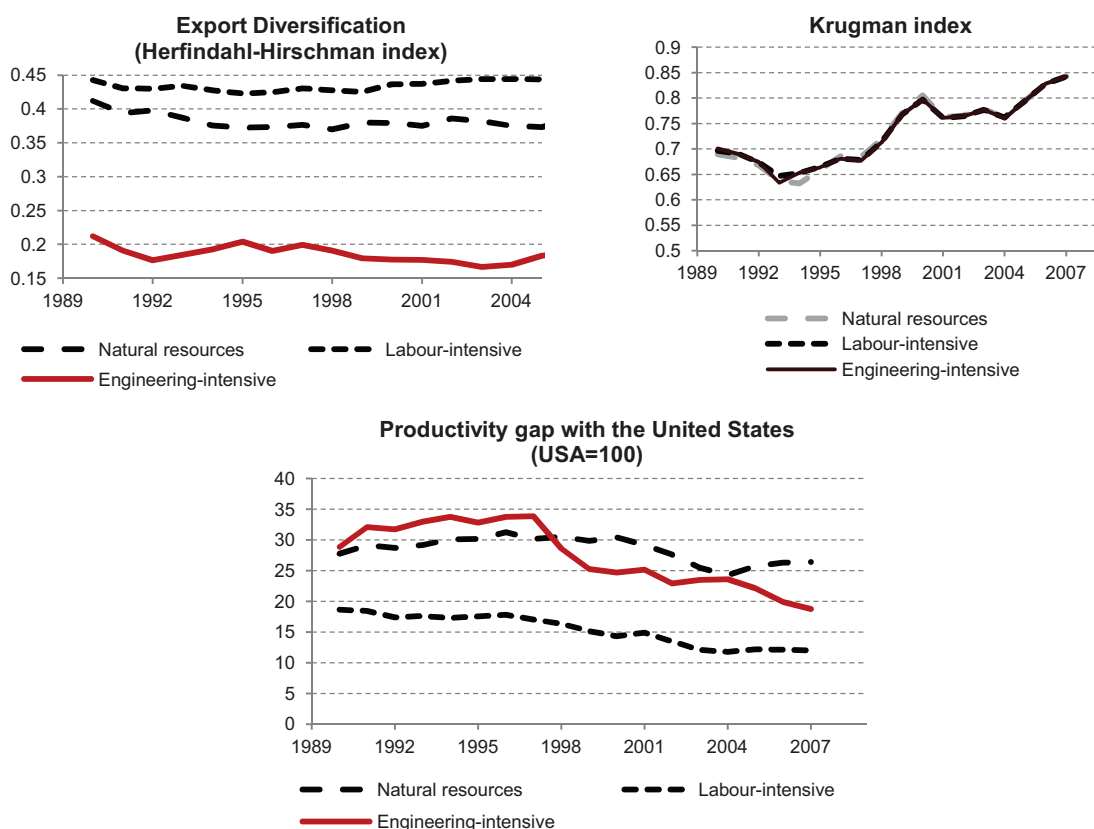intensity, external dependence, expansion of the technological frontier as proxied by the US productivity index, and the export and industrial concentration (see Figure 2). However, the scores of these industries in terms of intra-industry trade and the productivity gap with the United States were lower than one or the two other industry groups.

FIGURE 2
LATIN AMERICAN MANUFACTURING: MAIN TRENDS, 1990 TO 2008

(continued)

Figure 2 (concluded)

**Export Diversification
(Herfindahl-Hirschman index)**

- - Natural resources   - - - Labour-intensive
—— Engineering-intensive

Krugman index

- - Natural resources
- - - Labour-intensive
—— Engineering-intensive

**Productivity gap with the United States
(USA=100)**

- - Natural resources   - - - Labour-intensive
—— Engineering-intensive

Sources: Authors' calculations based on sources as described in Annex 1.

D. Econometric Analysis and Results

The following model regresses the impact of a set of variables related to the trade intensities and the industrial structure on the growth of the labor productivity, for a panel of five countries:

$$y_{ij,t} = \beta_1 y_{ij,t-q} + \beta_2 OR_{i,t-1} + \beta_3 X_{ij,t-p} + \varepsilon_{ij,t} \qquad (1)$$

Where $y_{ij,t}$ corresponds to the dependent variable of the model being labor productivity in industry j of country i in the year t. The explanatory variables are: $y_{ij,t-q}$ which is the lag of q periods of labor productivity, a reform index $OR_{i,t-1}$, and a vector of industry characteristics $X_{ij,t-p}$ of which some are included with a lag of p periods. This vector also describes the industry's exposure to international trade with the exports and external dependence coefficients. These two variables may present some endogeneity with labor productivity $y_{ij,t}$, which is controlled for during estimation procedures. Finally, $\varepsilon_{ij,t}$ is the random error of the model.

Model (1) was estimated using Ordinary Square Minimums in two-stages (2SLS) with and without correcting problems of identification in the errors. In addition to the endogeneity problem, the model has lags of the dependent variable, not observable fixed time effects and a larger cross section

country-industry dimension (ij) compared to the time dimension (t) (Roodman, 2006). With these characteristics, the correct approach would be Arellano-Bond differences GMM (1991). These estimators are unbiased, in contrast to those estimated using 2SLS with weak instruments, given that they are included as instruments the lags of the exogenous and endogenous variables.

The issue of unobservable fixed effects is also dealt with, as the transformation of the model (1) implies differences in each variable and its lags of the form:

$$\Delta y_{ij,t} = \beta_1 \Delta y_{ij,t-q} + \beta_2 \Delta OR_{i,t-1} + \beta_3 \Delta X_{ij,t-p} + \Delta \varepsilon_{ij,t} \qquad (2)$$

Where Δ corresponds to the differences. With this formulation the fixed effect is eliminated as it does not vary in the time. In other words, the differences in the error are:

$$\Delta \varepsilon_{ij,t} = \Delta v_{ij,t} + u_{ij,t} \qquad (3)$$

Where $\Delta v_{ij,t}$ are the not observable effects and $u_{ij,t}$ is the term of error. In this case, the difference $\Delta v_{ij,t}$ is zero.

In sum, this type of model introduces dynamic effects into the standard model of panel data by including a lag of the dependent variable on the right hand side, while correcting the endogeneity problem, fixed effects, short time span and possible autocorrelation. Notwithstanding the robustness of this dynamic model, it is not without criticism. In particular, it ignores whether the data are stationary or not. However, for this model no unit root test according to Fisher's test (Maddala and Wu, 1999) for panel data exists.

E. Estimation results

The estimation by Arellano-Bond GMM has shown to be robust to different specifications. We estimated four models, with the first corresponding to the full sample and other three referring to subsets of industries, except for engineering-intensive industries for which a dummy was included in the full set of manufacturing industries. The idea of running regressions for different subsets is to test the significance of the variables in the context of industries with different combinations of technologies in terms of natural resources, capital and labor.

The estimation results (see table 2) show that trade contributes significantly to labor productivity growth in different ways:

- The export coefficient (exports as a share of production) turns out significant and positive. The magnitude of this variable differs among groups of industries, being largest for the labor intensive group but insignificant for the natural resource group.

- The external dependence variable, showing imports as a proportion of the domestic demand for the products of a particular industry, also suggest an important effect on productivity growth. This variable is particularly important for the engineering intensive industries, but insignificant for natural resources intensive industries. The size of this variable is significantly larger than the export coefficient, suggesting this channel is more important.

- Export diversification or concentration also turns out to relevant and enters with a negative sign. This suggests that a more concentrated export basket (or higher value of the variable) has a negative effect on labor productivity growth. In other words, industries that produce a more diversified basket register a more dynamic productivity performance. When the concentration of the export basket increases, labor productivity growth would fall 6 per cent. For the industry groups it turns out that, in contrast to the previous two variables, the largest contribution is in the case of natural resource intensive industries.

- The other variable showing the "quality of trade" is the intra-industry trade index. Surprisingly, this variable is significant only in the case of the natural resource intensive industries.

- The de jure trade barriers, as proxied by the overall financial and trade index appear not to be significant. This may be due to the general character of this index, not being industry-specific.

In addition, this paper includes several control variables:

- The hypothesis that is rejected is the significance of the difference in the productive structure of each country with respect to the United States (Krugman index). A higher similarity was expected increase the productivity since would resemble the dynamics of production of an industrialized country, but this seems not the case.

- The industrial concentration seems significant for the performance of the labor productivity with an effect around 20 percent on labor productivity mainly in engineering intensive industries.

- Finally, the productivity gap variable turns out significant with a positive effect on the productivity growth. Since we control for movement of the frontier of productivity of US through the growth of this variable is found statistical significance in the case of labor intensive industries.

TABLE 2
DYNAMIC PANEL DATA ESTIMATION RESULTS USING GMM, 1990 TO 2008

Labor productivity growth	Total manufacturing	Total manufacturing + Engineering dummy	Natural resource intensive industries sample	Labor intensive industries sample
Productivity growth (L.1)	-0.31	-0.32	-0.29	-0.33
	(0.04)***	(0.04)***	(0.05)***	(0.07)***
Export intensity	0.05	0.05	0.01	0.07
	(0.02)**	(0.02)***	(0.02)	(0.03)***
External dependence	0.13	0.12	0.07	0.11
	(0.04)***	(0.04)***	(0.05)	(0.04)***
Export diversification	-0.06	-0.04	-0.08	-0.06
	(0.02)***	(0.02)***	(0.03)***	(0.02)**
Intra-industry trade	-0.06	-0.05	0.09	0.01
	(0.08)	0.08	(0.05)*	(0.07)
Reform index	0.39	0.35	0.05	0.12
	(0.24)*	(0.23)	(0.26)	(0.37)
Productivity gap	1.34	1.60	0.80	0.39
	(0.46)***	(0.49)***	(0.39)**	(0.39)
US productivity growth (L.2)	0.70	0.67	0.48	0.33
	(0.15)***	(0.15)***	(0.11)***	(0.26)
Krugman index	0.15	0.18	0.09	0.14
	(0.13)	0.14	(0.14)	(0.17)
Industrial concentration	1.98	2.38	2.06	1.53
	(0.88)	(0.91)***	(0.75)***	(0.86)*

(continued)

Table 2 (concluded)

Labor productivity growth	Total manufacturing	Total manufacturing + Engineering dummy	Natural resource intensive industries sample	Labor intensive industries sample
Dummy (Engineering Intensive)		0.04		
		(0.01)***		
Constant	-0.51	-0.52	-0.20	-0.23
	(0.22)**	(0.21)***	(0.24)	(0.34)
Number of observations	890	890	389	316
Number of groups	119	119	51	45
Wald test of joint coeff sig F=	126.4	132	75.6	42.4
prob>F	0	0	0	0

Source: Authors' elaboration.

Note: *** (99 percent) ** (95 per cent) and * (90 percent) of confidence.

IV. Concluding remarks

This paper aims to provide new empirical evidence on the role of international trade intensities in explaining productivity growth in 28 manufacturing industries in the five main economies of Latin America. Our results show that export intensity, as well as import penetration, have a positive impact on labor productivity. With regard to export intensity, the magnitude differs among groups of industries, being largest for the labor intensive group of industries and insignificant for the natural resources intensive group. The impact of import penetration on productivity depends on the industry, being significantly larger for the engineering intensive industries (impact of technology transfer and disciplinary effect) and insignificant for natural resources intensive industries. The role of import penetration on productivity is more important than the contribution of export intensity, suggesting than the first channel of transmission is the most relevant (disciplinary effect of imports).

Export concentration is also a relevant factor and impacts negatively labor productivity growth. A more diversified basket of exports is associated with a higher level of productivity growth. Intra industrial trade also impacts positively productivity, but only in natural resource intensive industries. These findings suggest that for natural resources intensive industries, a more diversified basket and the development of intra industrial trade would promote labor productivity growth. Policy makers should be working in this area, generating incentives for the development of intra industrial trade in the region and the diversification of exports in the industries where the region has a comparative advantage.

This paper could be extended in several ways.

- The measurement of the explanatory variables can be improved by using estimates that are currently being produced by the Latin America KLEMS project. This LA-KLEMS project, coordinated by ECLAC, develops estimates of Capital (K), Labor (L) and intermediate inputs of energy (E), materials (M) and services (S) at the sectoral level for the same countries as included in this paper plus some additional economies in the region. Within intermediate inputs, it separates domestic and imported intermediate inputs. Moreover, the database provides detailed a breakdown of the labor and capital contributions to economic growth. In sum, LA-KLEMS would allow a better measurement of productivity by multiple factor productivity (MFP) instead of labor productivity by industry. Another advantage is that it would allow the inclusion of imported intermediate inputs materials and services as another mechanism by which trade should improve productivity.

- Another improvement would be a better measurement of trade barriers. Instead of using a general reform index, the paper could estimate industry-specific tariffs.

- The paper could also consider include more variable in the current analysis, such as transport costs as highlighted by Pages (2010).

- The sample of countries could be extended to more countries in the region. Most countries in the region have surveys on manufacturing, being the sector best covered by regular statistics.

- It would be interesting to link the results at the meso level in by this paper with analysis at the micro level, as it has been shown that a great part of the productivity dynamics occurs within and among plants within the same industry. This has been done for example within the context of the KLEMS project for the European Union, see Bartelsman (2010). The combined micro and meso analysis could evaluate how much of the productivity dynamics within each country is at the meso and micro levels.

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Annexes

Annex 1

Description details of the independent variables

| ID	Variable Description	Unit	Formula	Type	Source
1	Growth of labor productivity in US	Growth rate	$\Delta ptusa = (\dfrac{ptusa_t}{ptusa_{t-1}} - 1)$ Where pt is labor productivity in country A and t is time.	year	PADI
2	Intra-industry trade index	Between 0 and 1	$\text{int } ra = [\dfrac{(\exp + imp) - \lvert \exp - imp \rvert}{(\exp + imp)}]$ Where exp are exports and imp are imports	country-industry	PADI
3	Labor productivity gap with respect to the United States	Between 0 and 1	$gap = [(\dfrac{pt}{pt_{USA}})]$ Where pt_{USA} is US labor productivity	country-industry	PADI
4	Herfindahl index of industrial concentration based on numbers of firm, assuming equal share of market by each ones	Between 0 and 1	$herf = [(\dfrac{1}{firms})]$ Where $firms$ is the number of firms by industry	country-industry	UNCTAD, CEPII
5	Diversification of exports (FOB) calculated from SITC Rev.2	Between 0 and 1	$herf\_fob = \sum S_i^2$ Where S_i^2 is the share by product in the total of trade by industry	country	Comtrade
6	Krugman specialization index	Between 0 and 2	$ki = \sum \lvert S_{ji} - S_{Ri} \rvert$ With S_{ji} the share of industry i in the value added of country j and S_{Ri} the same in the United States	country	Author
7	Combined trade openness and financial market reform index (Reform index)	Between 0 and 1	$ind\_ap = (ind\_t + ind\_ffmm)/2$ Where ind_t is an index of trade openness and ind_ffmm and index of financial market reform	country	Morley, Machado and Pettinato (1999)
8	External dependence	Growth rate	$g\_dexrma = \dfrac{imp}{prod + (imp - \exp)}$ Where $prod$ is the production value	country-industry	PADI
9	Coefficient of exports	Growth rate	$g\_c\exp ma = \dfrac{\exp}{vbp}$	country-industry	PADI

Source: Authors' elaboration.

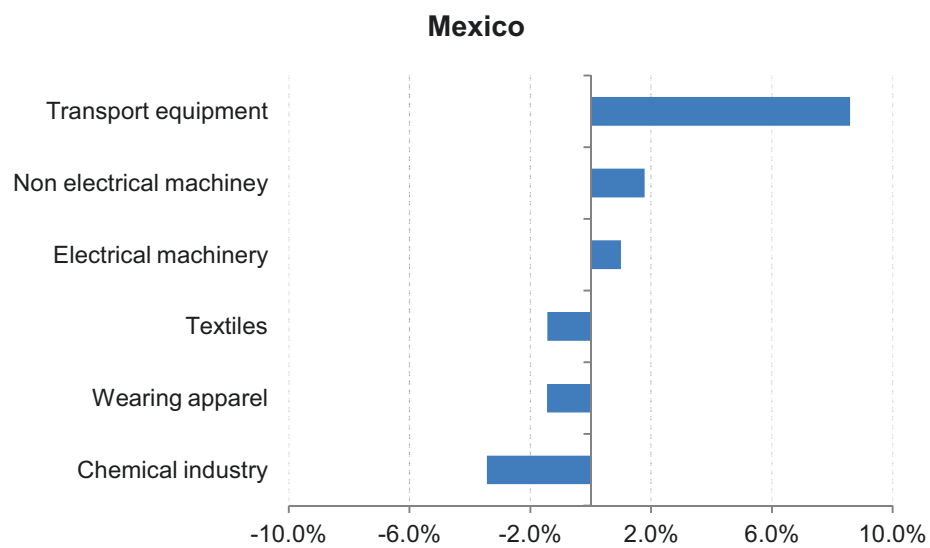## Annex 2

Changes in Value Added Shares (1990 to 2008)

Argentina

Brazil

Chile

Colombia

Mexico
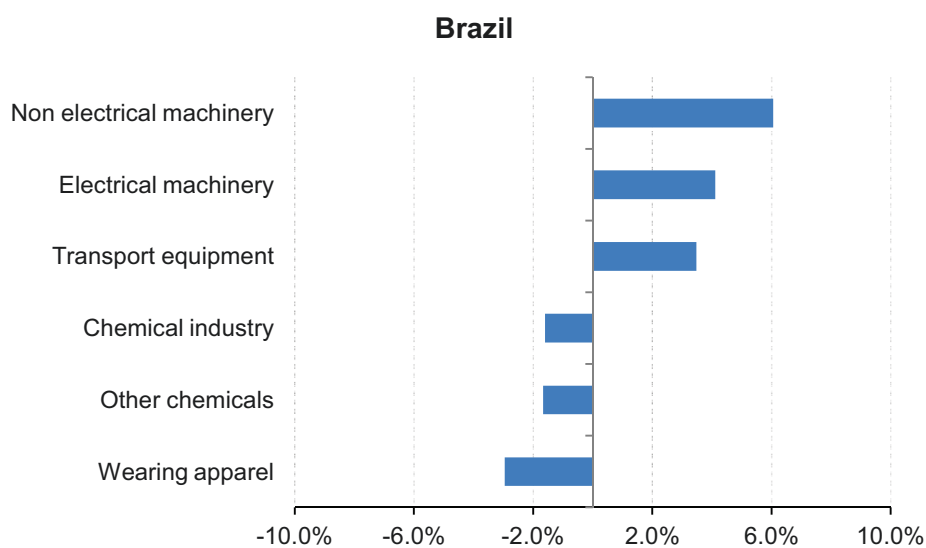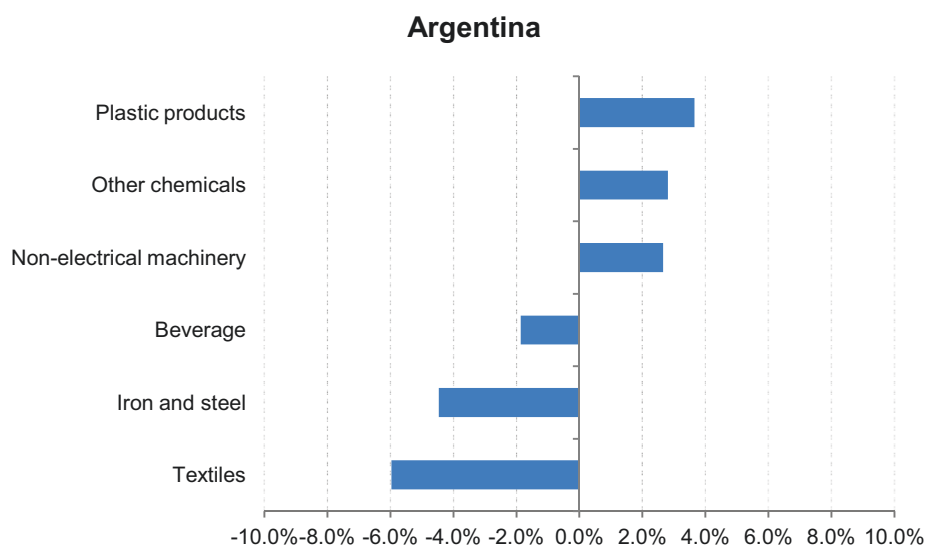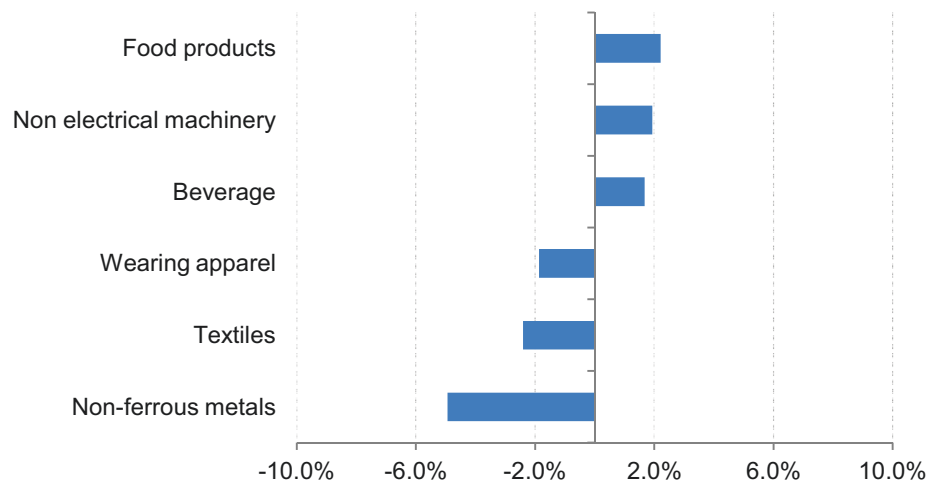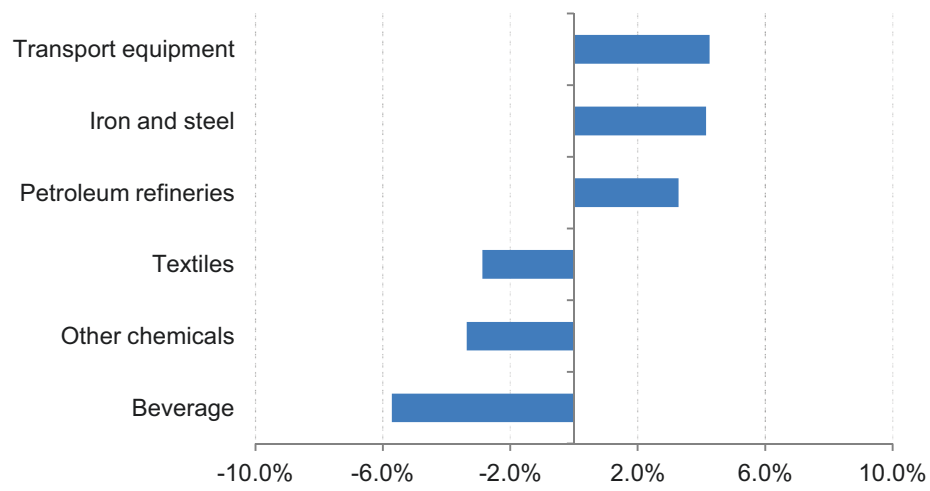
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