*Policy Reform*, March 2003, Vol. 6(1), pp. 1–15

# Trade Liberalization and Productivity Growth in Latin American Manufacturing, 1970–98

EVA PAUS,[a,*] NOLA REINHARDT[b] and MICHAEL ROBINSON[c]

[a,b]*Mount Holyoke College;* [c]*Smith College*

*(Received September 2002; In final form April 2003)*

We examine the relationship between trade liberalization and manufacturing labor productivity growth for 27 industries in seven Latin American countries from 1970 to 1998. Our trade variables are export and import growth and a commercial reform index, which capture the various channels through which productivity and trade liberalization may be related. Using the Arellano–Bond GMM estimator, we find a significant positive correlation between all three variables and productivity growth. US productivity growth and distance behind best-practice technology are also significantly correlated with productivity growth. These results have to be understood in the context of sweeping economic reforms and continuing economic difficulties in the countries under investigation.

**Key words:** Latin American Manufacturing; Productivity Growth; Trade Liberalization

*JEL Codes*: O0

## 1 INTRODUCTION

Belief in the economic benefits of free trade has led to a global process of trade liberalization in the past few decades. Despite this, there is much that we do not yet know about the impact of trade liberalization. This is particularly the case with respect to one of the most important potential benefits, productivity growth. Empirical investigations of the trade–productivity relationship have produced conflicting results, especially regarding the precise channels by which trade liberalization has affected the decisions of firms and their resulting productivity growth.

In this paper we investigate the link between trade liberalization and productivity growth in the Latin American manufacturing sector between 1970 and 1998. The region as a whole has experienced an unprecedented opening up to international trade since the mid–1980s (IDB, 1997, pp. 41–42; Morley *et al.*, 1999), with average tariffs falling from around 42 percent in 1986 to around 21 percent by 1990, and further to around 12 percent in 1995. Differences among countries declined dramatically, as average tariffs for individual countries ranged from 30 to over 100 percent in 1986, compared to a much narrower range of 10 to 18 percent in 1995. Within countries, as well, tariff dispersion dropped significantly in this period, from an average variance of 20 percent to 6.4 percent. Non-tariff barriers have also been sharply reduced for eleven countries in the region for which there is evidence.

*Corresponding author. Mount Holyoke College, Department of Economics, 50 College Street, South Hadley, MD 01075, USA. Tel.: 413–538–2432; E-mail: epaus@mtholyoke.edu

ISSN 1384-1289 print; ISSN 1477-2736 online © 2003 Taylor & Francis Ltd
DOI: 10.1080/1384128032000101394

Based on recent CEPAL data on manufacturing activity in Latin America, we investigate the relationship between trade opening and productivity growth at the 3-digit ISIC level for seven Latin American countries during 1970–98. Our results suggest that trade liberalization over this period was associated with higher levels of manufacturing productivity growth for these countries. The results are compatible with the hypotheses that the impact of trade opening occurred through import competition, capital goods imports, and export effects. However, other factors which we cannot capture empirically at the 3-digit ISIC level may have played an important role as well, namely, the increase in direct foreign investment and the impact of concomitant reforms such as stabilization policies and liberalization of the capital account. In addition, we find that external factors, such as the rate of global productivity growth, have also had a significant effect on industry-level productivity growth.

Nonetheless, productivity growth in Latin American manufacturing was associated with some disturbing trends in the sector's performance, with a decline in output growth, export growth, and employment in a number of countries. And trade liberalization led to a restructuring of the manufacturing sector with a resurging importance of natural resource based sectors, which may adversely affect the potential for long-run productivity growth.

In the next section we provide a brief literature survey on the link between trade liberalization and productivity growth. We discuss our analytical framework and the empirical results in Section 3 and policy implications in the concluding section.

## 2 TRADE OPENING AND MANUFACTURING PRODUCTIVITY: THEORY AND EVIDENCE

The theoretical literature advances three main arguments about the channels through which trade liberalization would increase productivity growth (see, for example, Edwards, 1998; Tybout, 2000). First, a reduction in trade barriers increases the competitive pressures on domestic producers in import-competing industries, inducing them to reduce X-inefficiencies, to introduce technological change through new investment, or to exit the industry.[1] Second, lowered protection makes it cheaper to import capital goods and therefore facilitates access to foreign technology by all firms. And finally, trade liberalization changes the relative prices between exportables and import substitutes, making exporting relatively more attractive. Increased exports can lead to higher productivity growth through scale effects and increased awareness of best-practice technology and production techniques abroad.

Empirical investigations of the trade liberalization–productivity relationship have employed varying methodologies with conflicting results. They can be divided into three broad groups: studies of aggregate productivity growth, industry-level productivity studies, and plant-level studies.

The aggregate studies focus on the overall impact of trade liberalization on productivity growth, without exploring the underlying causal mechanisms. These cross-country studies generally find a positive and statistically significant relationship between productivity growth and trade opening (*e.g.*, Edwards, 1998; Tybout and Westbrook, 1995; Tybout *et al.*, 1991). In one of the first empirical investigations of the impact of the new economic model in Latin America, the IDB (1997) comes to similar conclusions. They find that over the period 1984–95 trade opening was significantly related to total factor productivity growth for 19 Latin American countries.

[1] In contrast to allocative inefficiency, X-inefficiency refers to intra-firm inefficiency, which can result from such factors as a suboptimal organization of the production process, for example. See the seminal article on X-efficiency by Leibenstein (1966).

Other studies are skeptical of these findings. Rodriguez and Rodrik (1999) critique the Edwards study on methodological grounds. Tybout (2000), similarly, argues that these aggregate studies suffer from a number of weaknesses, including the possible confusion of interpreting lower price–cost ratios as a sign of increased productivity rather than lowered mark-ups. Overall, he concludes that plant- and industry-level studies that attempt to identify the actual channels by which liberalization affects productivity growth offer the greatest promise for understanding the trade regime–productivity growth relationship.

## 2.1 Competitive Pressures from Imports

In the neo-classical model, with its assumptions of perfect competition, the effects of increased import competition on productivity growth is straightforward. The individual firm in the previously protected industry will now face lower prices, and therefore move down the short-run supply curve. In the long run, firms will be under pressure to lower costs, which will be possible through investment in new technology, thus shifting the supply curve downwards. If we relax the assumption of perfect competition, it is also possible that X-inefficiency existing before liberalization can be reduced. Firms that are not able to lower costs in line with the new lower long-run price will be forced to exit the industry. Furthermore, if we relax the assumption of the representative firm in each industry and allow for initial differences in firm size and productivity, trade opening can also lead to reduced productivity dispersion in these industries.

In practice, the outcomes are not so clear-cut. As Tybout (2000) points out, the effects of trade liberalization on the decisions of the individual firm depend on a variety of factors, including industry structure and institutional setting. Exit barriers may slow the long-run adjustment process. Also firms in import-competing industries may decrease, rather than increase, investment, because competition reduces market size and thus the payoff to lowering marginal cost. On the other hand, if domestic competition had previously been sufficient to keep inefficiency low, the effect of liberalization on X-inefficiency would be small. Empirical studies of the market disciplining function of increased imports do not come to uniform conclusions. While a number of studies find a negative correlation between import penetration and price–cost margins (surveyed in Tybout, 2000), studies that focus explicitly on the impact on productivity growth show mixed results (see Haddad *et al.*, 1996; Pavcnik, 2000; Yean, 1997).

## 2.2 Imports of Capital Goods and Access to Foreign Technology

Aside from reducing X-inefficiency, the main venue for increasing firm-level productivity after liberalization is through easier access to lower cost and/or higher quality imported intermediate and capital goods. The ability of a firm to make such investments depends, however, on access to knowledge and financing, which may not improve with liberalization.

Overall, the empirical evidence supports the important role of increased capital goods imports for domestic productivity growth (Sjoeholm, 1999; Tybout, 2000). Nevertheless, if the positive spillover effects of domestic learning-by-doing in existing high-tech sectors are larger than the externalities from imported technological know-how, then a reduction in tariff protection of these sectors could actually lead to lower productivity growth. Although Chuang (1993, 1996) finds a generalized trade-induced learning effect associated with imports and exports of machinery, the verdict on whether there is a substitute for domestic learning-by-doing in all cases is still out.

### 2.3 Exports and Economies of Scale

When trade liberalization leads to higher investment (with or without imported capital goods and technology), firms may achieve economies of scale in industries where they exist. Although such increased output does not necessarily have to translate into greater exports, with a relative price change that reduces or eliminates the anti-export bias of the previous protection era, producers now have a greater incentive to sell on the international market. Exporting may further increase productivity growth as producers gain knowledge of best-practice production through their contacts with buyers on the international market.

A number of studies have found that increased exports have been positively correlated with productivity growth (Aswicahyono *et al.*, 1996; Bonelli, 1992; Haddad *et al.*, 1996; Nishimizu and Robinson, 1984; Sjoeholm, 1999; Weinhold and Rauch, 1997; Yean, 1997). Whether this is due to economies of scale, technological innovation, or other factors is not clarified in these studies. Pavcnik's plant-level study (2000) found that continuing export-oriented firms in Chile did not increase their productivity relative to nontradables, perhaps because they had already been operating at high levels of productivity in order to be competitive in export markets.

Indeed, one of the key questions in the export–productivity–growth nexus is the direction of causality between the two. Does export growth foster productivity growth, or do firms with high productivity growth become sufficiently competitive internationally to be able to export? While a few studies have found evidence to indicate that causality runs from export growth to productivity growth (*e.g.*, Haddad *et al.*, 1996), others suggest that the causality runs from productivity to export growth (*e.g.*, Pavcnik, 2000; Aw *et al.*'s findings for Taiwan, 1997, reported in Pavcnik, 2000; Clerides *et al.*, 1998). Tracing export, productivity and cost trajectories at the plant level in Colombia, Mexico, and Morocco, Clerides *et al.* (1998) find that low cost firms self-selected into exporting, and that exporting did not lower costs further.

### 2.4 Summary

In summary, the empirical literature provides mixed evidence about the consequences of trade liberalization. There is substantial empirical support for the importance of increased capital goods imports in enhancing productivity growth, at least in the short run. The evidence is mixed, however, regarding the impact of increased import penetration on productivity growth. And while many studies show a positive and statistically significant link between export growth and productivity growth, there is also significant evidence that the causality runs from productivity growth to export growth rather than the other way round.

## 3 TRADE LIBERALIZATION AND PRODUCTIVITY GROWTH IN LATIN AMERICA: ANALYTICAL FRAMEWORK AND EMPIRICAL RESULTS

We focus our analysis on productivity growth in the manufacturing sector over the years 1970–98 in seven Latin American countries: Argentina, Brazil, Chile, Colombia, Mexico, Peru, and Uruguay.[2] According to Stallings and Peres (2000) and Morley *et al.* (1999), major

[2]The choice of countries is limited by the reliability of country data on manufacturing activity, as well as by the last year for which a country's data are available.

TABLE I Commercial Reform Index for Latin American Countries.

| | *1970* | *1980* | *1990* | *1995* |
|---|---|---|---|---|
| Argentina | 0.546 | 0.768 | 0.890 | 0.934 |
| Brazil | 0.493 | 0.467 | 0.770 | 0.930 |
| Chile | 0.126 | 0.974 | 0.961 | 0.984 |
| Colombia | 0.635 | 0.757 | 0.849 | 0.952 |
| Mexico | 0.714 | 0.884 | 0.953 | 0.909 |
| Peru | 0.516 | 0.730 | 0.563 | 0.941 |
| Uruguay | 0.000 | 0.557 | 0.848 | 0.957 |
| Unweighted av. | 0.433 | 0.734 | 0.833 | 0.944 |

*Source*: Morley *et al.* (1999).

free-market reforms started in 1985 in Mexico and Chile (second phase),[3] in 1990 in Argentina, Brazil, Colombia, and Peru; and in 1991 in Uruguay. Besides trade liberalization, the reform strategies included privatization of state-owned enterprises, fiscal reforms, deregulation, liberalization of the financial market, and some liberalization of the labor market.

The commercial reform index in Table I illustrates the progression of trade liberalization described above. The index, constructed by Morley *et al.* (1999), is based on the average tariff level and the dispersion of tariffs. It ranges from 0 to 1, with a higher number indicating a higher degree of trade liberalization.[4] By 1995, the average reform index had increased to 0.944, from 0.734 in 1980 and 0.433 in 1970. The range among the countries had narrowed to 0.89 to 0.99 in 1995, from 0.24 to 0.88 in 1985. The commercial reform index does not control for the possibility of excess protection,[5] and it does not include non-tariff restrictions. But we know from other sources that non-tariff barriers had declined considerably by the first half of the 1990s.[6] Thus Latin American economies provide a fertile ground to explore the link between trade liberalization and productivity growth.

## 3.1 Analytical Framework

To analyze the link between trade opening and industry productivity growth, we adopt an analytical framework that incorporates the different channels behind the trade liberalization–productivity nexus and industry characteristics.

### *3.1.1 Productivity Growth*

Our dependent variable is productivity growth. We measure productivity as *labor productivity* instead of total factor productivity, due to the lack of industry-level investment data for Latin American countries. We use data at the 3-digit ISIC level, as this is the most

[3]Chile had already aggressively pursued free-market policies in the 1970s, under the Pinochet regime, including a dramatic reduction in tariff protection that was reversed temporarily with the crisis on the early 1980s.

[4]The authors interpolated values for years where no data were available (Morley *et al.*, 1999).

[5]Morley *et al.* (1999, p. 8) discuss the possibility that their commercial reform index may overstate the degree of liberalization, if there was excess protection before; *i.e.*, if the domestic price is below the international price times one plus the tariff rate.

[6]UNCTAD (1994) shows that between the mid–1980s and 1993, the incidence of non-tariff measures had declined from 21.2 percent to 3.1 percent in Argentina, from 44.1 percent to 14.3 percent in Brazil, from 16.1 percent to 0.4 percent in Chile, and from 24.1 percent to 19 percent in Mexico.

disaggregated information available in the only comprehensive data set on the Latin American manufacturing sector. As a result, we know whether there was labor productivity growth, but we cannot pinpoint the extent to which it was due to increases in capital deepening (more investment per worker), to increases in total factor productivity, or to the exit of inefficient firms.

We include *past productivity growth* as an independent variable. If there is a trend effect, with past productivity growth perhaps indicating the ability to innovate, the coefficient on this variable will be positive. On the other hand, the coefficient may be negative if firm innovation tends to be lumpy.

### 3.1.2 Trade Opening

As discussed earlier, there are three principal paths through which trade opening can increase an industry's productivity. We include a variable for *import growth* to capture the effects of increased competition for import-competing firms. We include *export growth* to capture the possible impact of export-related scale economies and knowledge effects.

We include a *commercial reform* variable in an attempt to capture indirectly some of the impact of increased capital goods imports. An increase in trade liberalization for a particular product should have a direct effect on the imports and exports of that product, both of which are included in the model. If it has a separate positive effect on productivity growth, over and above the direct impact on the trade variables, that may reflect increased firm imports of capital goods.

### 3.1.3 Industry Characteristics

While trade opening increases the incentives and possibilities for firms to raise productivity, other industry characteristics influence how firms react to these new pressures and opportunities. Important factors are the extent to which the domestic industry is behind the industry's international productivity frontier and the pace of global technological development in the industry.

The extent to which the firms in the industry are behind the international best-practice frontier (the productivity "gap") is a measure of the possibilities for "catching up" or convergence. The closer the firms are to the frontier, the less scope there is to increase productivity by importing international practices under trade opening. However, if the frontier itself is moving – that is, if the industry is experiencing rapid technological advance – there will be more scope for imported technological improvements, whatever the productivity gap. To measure the *productivity gap* we use labor productivity in the industry relative to US labor productivity and we use *US labor productivity growth* to measure the growth in the frontier.

## 3.2 Data and Structural Equation for the Empirical Estimation

To examine these various effects, we specify the following basic equation, where productivity growth depends on past productivity growth, trade openness, and industry characteristics:

$$lp_{jit} = \beta_0 + \beta_1 lp_{jit-1} + \beta_2 x_{jit} + \beta_3 m_{jit} + \beta_4 cr_{jt-1} + \beta_5 lp_{USit} + \beta_4 relp_{jit-2} + c_{ji} + \varepsilon_{jit} \quad (1)$$

where:

$lp_{ijt}$: growth of value added per worker
$x_{ijt}$: growth of exports
$m_{ijt}$: growth of imports
$cr_{jt-1}$: index of commercial reform
$relp_{jit-2}$: ratio of real valued added per worker in sector *i*, country *j*, to real value added per worker in sector *i* in the United States
$lp_{USit}$: growth of value added per worker in the United States.
$c_{ji}$: specific country/industry effect.
$i = 1, \ldots, 27$ (3-digit ISIC sector)
$j = 1, \ldots, 7$ (Latin American countries)
$t = 1, \ldots, 10$ (three-year average periods between 1970 and 1999)

The *time periods* for all variables are defined to be three-year averages, beginning with 1970–72, and ending with 1997–99. In the cases where the initial or final year was missing for an industry we used the two-year average of the available data. We use three-year averages both to smooth out annual variations and to capture the fact that the impact of each variable may take longer than one year to be fully realized. We lag the index of commercial reform by one period, which implies that the level of commercial reform at time *t*-1 impacts the growth in productivity from *t*–1 to *t*. Since the dependent variable is productivity growth we lag the relative productivity (relp) by two periods to ensure it is exogenous. For the growth rate variables, growth at time *t* was computed as the difference in the natural log from *t* to *t*-1.

Firm behavior is, of course, also influenced by a host of other economic factors. Those include macro economic factors like inflation and real interest rates, general market conditions at home and abroad, investor confidence and expectations, etc. We therefore include a country/sector specific effect.

With the exception of the commercial reform variable all the data for our regression analysis are from a data set on industrial statistics for Latin America put together by the Economic Commission on Latin America and the Caribbean (CEPAL, 2000).[7] Labor productivity is defined as real value added per employee. Value added, output, and trade data are given in real US dollars, based on 1985 prices. The commercial reform index which we take from Morley *et al.* (1999) is only available at the country level. Thus we are not able to differentiate degrees of commercial reform across 3-digit ISIC levels.

## 3.3 Estimation and Results

### *3.3.1 Methodology*

To eliminate the country/sector specific effects we first difference in Equation (1). This leaves us with Equation (2), which we estimate using instrumental variables. We estimate (2) using the Arellano–Bond GMM estimator (Arellano and Bond, 1991; Bailliu, 1998).

$$\begin{aligned} lp_{jit} - lp_{jit-1} = {} & \beta_1 (lp_{jit-1} - lp_{jit-2}) + \beta_2 (x_{jit} - x_{jit-1}) + \beta_3 (m_{jit} - m_{jit-1}) + \\ & \beta_4 (cr_{jt-1} - cr_{jt-2}) + \beta_5 (lp_{USit} - lp_{USit-1}) + \\ & \beta_6 (relp_{jit-2} - relp_{jit-3}) + \varepsilon_{jit} - \geq_{jit-1} \end{aligned} \quad (2)$$

[7] The data set is called PADI, Programa de Analisis de la Denamica Industrial. It is put together and issued by the Industrial Development Division of the United Nations Commission on Latin America and the Caribbean in Santiago, Chile. The data cover only firms with more than 49 employees.

TABLE II Variable Means and Standard Deviations.

| *Variable* | *Mean* | *SD* |
|---|---|---|
| Growth in productivity | 0.054 | 0.231 |
| Index of commercial reform | 0.702 | 0.237 |
| Relative productivity | 31.50 | 23.19 |
| Growth in US productivity | 0.060 | 0.119 |
| Growth in exports | 0.296 | 0.748 |
| Growth in imports | 0.238 | 0.713 |

Since our dependent variable is measured as the change in value added per worker and value added would contain exports, we treat the export variable as endogenous for purposes of the estimation. In order to make sure our results are not sensitive to our estimation technique we also estimated (1) using a GLS estimator treating the country/sector as random effects. The results were qualitatively similar to those reported in the paper for the Arellano–Bond GMM estimator and are available from the authors.

We estimated (2) for the period 1970–98 for all seven countries and for 27 industries at the 3-digit ISIC level.[8] Table II shows the means and standard deviations of the variables used in the estimation.

### 3.3.2 Results for the Whole Time Period and Subperiods

We estimated (2) for the whole time period, and for the 1970s/80s and 1990s separately. To explore any factor-related differences in the determinants of productivity growth, we also estimated the model separately for the whole period for three broad industrial groups: human capital intensive (HCI), labor intensive (LI), and natural resource intensive (NRI).[9] Table III presents the results.

The coefficients on the trade variables provide support for the hypothesis that trade liberalization has a positive impact on productivity growth. Import growth and export growth were positively and significantly correlated with productivity growth in the full sample.

The results are consistent with the hypothesis that exporting enhances a firm's knowledge of global practices in ways that can lead to greater productivity growth. As noted in Section 2, however, the direction of causality between the two variables is the subject of some debate. Firms with higher productivity growth may be the ones that have achieved faster export growth. Our Granger causality tests suggest substantial two-way causality between productivity growth and export growth.[10]

[8]The ISIC classification system groups manufacturing activities into 28 categories at the 3-digit level. We excluded petroleum refining, ISIC 353, because for all countries the data reliability was dubious, as productivity data were total outliers. Also, there is a break in the Mexican export series, with maquila exports excluded before 1992, but included afterwards. Instead of excluding all of Mexico's data, we excluded the four sectors, which account for most of the maquila exports: 321, 322, 382, and 384.

[9]Following Katz and Stumpo (2001), human capital industries include ISIC sectors 381, 382, 383, 384, 385; labor intensive are sectors 321, 322, 323, 324, 332, 342, 352, 356, 361, 390; and natural resource intensive are 311, 313, 314, 331, 341, 351, 354, 355, 362, 369, 371, 372. We did not estimate the model for the three groups for the subperiods, since the number of observations becomes too small for the 1990s at that level of disaggregation.

[10]In order to test for the direction and existence of causality between export growth and productivity growth, we estimated granger causality tests (with five period lags) with annual data between 1970 and 1999 for each of 180 country–industry combinations in our sample. In 49 percent of the cases we find evidence that productivity growth causes export growth and in 53 percent of the cases we find evidence that export growth causes productivity growth. On the other hand, in a large number of cases we find no link in a simple causality, which suggests that the relationship is mediated by other factors.

TABLE III Arellano–Bond Estimates of Productivity Growth Model Panel Data 1970–1999: Dependent Variable: Productivity Growth$_t$

| | *Full sample* (1) | *Human capital intensive* (2) | *Labor intensive* (3) | *Natural resource intensive* (4) | *1990s* (5) | *1970s and 1980s* (6) |
|---|---|---|---|---|---|---|
| Productivity growth$_{t-1}$ | −0.174** | −0.178** | −0.184** | −0.268** | −0.163** | −0.253** |
| | (0.038) | (0.084) | (0.065) | (0.049) | (0.054) | (0.053) |
| Import growth$_t$ | 0.075** | 0.173** | 0.070** | 0.054** | 0.059** | 0.078** |
| | (0.009) | (0.042) | (0.010) | (0.016) | (0.013) | (0.012) |
| Export growth$_t$ | 0.039** | 0.052 | 0.023 | 0.075** | 0.021 | 0.042 |
| | (0.020) | (0.047) | (0.020) | (0.026) | (0.028) | (0.027) |
| US productivity growth$_t$ | 0.191** | 0.690** | −0.430** | 0.242** | 0.486** | 0.180** |
| | (0.059) | (0.117) | (0.112) | (0.078) | (0.093) | (0.077) |
| Relative productivity$_{t-2}$ | −0.006** | −0.010** | −0.005** | −0.006** | −0.005** | −0.007** |
| | (0.001) | (0.004) | (0.002) | (0.001) | (0.001) | (0.001) |
| Commercial reform$_{t-1}$ | 0.231** | 0.129 | 0.363** | 0.236** | 0.341** | 0.197** |
| | (0.061) | (0.137) | (0.087) | (0.088) | (0.129) | (0.076) |
| Intercept | −0.004 | −0.018* | −0.001 | −0.006 | 0.015 | −0.017** |
| | (0.004) | (0.010) | (0.006) | (0.006) | (0.012) | 0.007 |
| Wald | 196.53 | 87.61 | 138.79 | 114.37 | 108.55 | 115.40 |
| *N* | 1193 | 210 | 445 | 538 | 495 | 698 |

*Note*: Export growth treated as an endogenous variable.
* Significant at the 90 percent level; **significant at the 95 percent level; standard errors in parentheses.

Given the level of aggregation at the industry level, we are not able to conclusively determine the avenues by which import penetration led to productivity growth – whether through firm exit, decreased X-inefficiency, or investments in new plant and equipment. The high decline in manufacturing employment in the 1990s (see Table IV) suggests, however, that bankruptcies in inefficient firms and/or reduction in X-inefficiency in continuing firms account for part of the increase in productivity growth here, especially since productivity is defined as value added per worker. A number of more detailed studies confirm this conjecture. Based on firm-level data, Pavnik (2000) finds that the exit of less efficient firms led to industry productivity growth in Chile between 1979 and 1986. With respect to Argentina's iron and steel industry, an industry where Argentina narrowed the productivity gap with the United States, Katz (2000) points out that the number of plants declined from 42 in 1985 to 26 in 1992.

In our estimates, the positive and significant coefficient for the commercial reform index is an indication that labor productivity growth was affected positively by tariff reductions over and above their direct impact on exports and imports. If we think about the substance of the indirect effects of reducing trade barriers, then access to cheaper capital goods from abroad seems to be the most likely factor. The coefficient is considerably larger for the 1990s than for the previous two decades. This is consistent with investigations of recent firm behavior in Latin America. Macario (2000, p. 1601), for example, found that 85 percent of the firms in her cross-country sample had significantly increased the use of imported inputs in response to competitive pressures. Stallings and Peres (2000, pp. 80–83) also found that investment in new equipment characterized firm response in the 1990s, although they caution that this investment was in all likelihood a transitory or "one-time" event undertaken to achieve a new level of

TABLE IV Selected Means by Country and Decade for Total Manufacturing.

| | *Labor productivity growth* | | | *Relative labor productivity* | | | *Output growth* | | |
|---|---|---|---|---|---|---|---|---|---|
| | *1970s* | *1980s* | *1990s* | *1970s* | *1980s* | *1990s* | *1970s* | *1980s* | *1990s* |
| Argentina | 3.02% | 2.19% | 7.76% | 35.23% | 43.87% | 49.09% | 2.41% | –1.70% | 5.01% |
| Brazil | 3.64% | 0.40% | 7.49% | 27.13% | 26.50% | 25.59% | 9.04% | 1.89% | 0.25% |
| Chile | 2.38% | 1.71% | 3.78% | 29.09% | 36.46% | 30.02% | 5.08% | 4.41% | 3.86% |
| Colombia | 1.76% | 1.80% | 3.68% | 26.57% | 28.78% | 25.92% | 6.39% | 2.46% | 1.85% |
| Mexico | 3.02% | 2.67% | 3.77% | 28.25% | 32.55% | 32.97% | 5.68% | 1.87% | 4.15% |
| Peru | –0.01% | –3.98% | 2.12% | 24.05% | 21.28% | 11.78% | 3.76% | 0.24% | 3.52% |
| Uruguay | –1.11% | –0.31% | 5.51% | 23.69% | 21.06% | 15.56% | 3.58% | 1.38% | –2.07% |
| | *Exports/output* | | | *Imports/(imports + output)* | | | *Commercial reform index* | | |
| | *1970s* | *1980s* | *1990s* | *1970s* | *1980s* | *1990s* | *1970s* | *1980s* | *1990s* |
| Argentina | 5.91% | 7.51% | 10.03% | 6.50% | 6.37% | 12.31% | 0.570 | 0.750 | 0.912 |
| Brazil | 7.97% | 11.84% | 17.00% | 9.11% | 5.31% | 13.97% | 0.508 | 0.510 | 0.873 |
| Chile | 25.84% | 22.18% | 23.30% | 16.52% | 17.21% | 22.79% | 0.623 | 0.936 | 0.978 |
| Colombia | 6.73% | 6.80% | 13.47% | 15.68% | 17.53% | 25.08% | 0.708 | 0.698 | 0.927 |
| Mexico | 3.98% | 7.87% | 32.56% | 9.77% | 12.04% | 28.10% | 0.848 | 0.845 | 0.945 |
| Peru | 13.02% | 9.63% | 12.18% | 13.07% | 11.65% | 14.06% | 0.507 | 0.623 | 0.843 |
| Uruguay | 17.72% | 21.81% | 25.40% | 14.62% | 13.71% | 24.12% | 0.083 | 0.714 | 0.912 |
| | *Export growth* | | | *Import growth* | | | *Employment growth* | | |
| | *1970s* | *1980s* | *1990s* | *1970s* | *1980s* | *1990s* | *1970s* | *1980s* | *1990s* |
| Argentina | –4.50% | 12.77% | 3.07% | –1.49% | 1.45% | 24.59% | –0.48% | –3.66% | –2.57% |
| Brazil | 11.74% | 6.21% | 10.42% | 10.42% | –1.07% | 25.10% | 6.19% | 1.92% | –6.69% |
| Chile | 9.53% | 5.16% | 2.78% | 8.14% | 7.96% | 8.24% | –0.95% | 2.06% | 0.91% |
| Colombia | 17.95% | 7.33% | 7.10% | 5.75% | 3.89% | 10.96% | 4.66% | –0.45% | –1.44% |
| Mexico | 8.42% | 16.80% | 26.90% | 10.40% | 6.33% | 28.01% | 3.22% | –0.51% | 0.18% |
| Peru | 4.71% | –5.17% | 12.29% | 2.74% | –1.64% | 14.06% | 3.29% | 3.83% | 1.54% |
| Uruguay | 11.11% | 5.95% | 2.01% | 8.17% | 4.89% | 10.15% | 5.27% | 2.24% | –7.18% |

*Source*: Calculated from CEPAL (2000), except for the Commercial Reform Index which is based on Morley *et al.*'s (1999) and refers to the aggregate economy, rather than the manufacturing sector specifically.

competitiveness. This is consistent with the negative coefficient on the past productivity growth variable.

In interpreting these results, it is also important to keep in mind that trade liberalization was generally introduced in these countries as part of a broader reform package that included stabilization and privatization policies. The significantly larger coefficient in the 1990s suggests that the impact of trade liberalization may in fact be capturing the positive effect on investment of these other reform elements. Indeed, Stallings and Peres (2000, pp. 86–88) find that inflation had a significant negative impact on investment over the 1979–85 period. They also find that external debt was associated with significantly reduced investment rates.

The positive and significant coefficient on US productivity growth is a particularly interesting result, since it suggests a strong spillover effect from outward movements in the international technology frontier. It seems likely that greater openness in the 1990s enhanced the impact of this factor, as firms had greater access to foreign technology, through exporting or the import of capital and intermediate goods. A larger presence of MNCs could also account for part of the increase. Multinationals can serve as an important vehicle for the

transfer of technology, and it is logical to suppose that they would be strongly influenced by global technological developments. Direct foreign investment increased from 3.8 percent of Latin American gross fixed capital formation in 1990, to 18.6 percent in 1997 (Mortimore, 2000, p. 1612).

While global technological change was an important source of productivity growth, the negative and significant coefficient on the productivity ratio indicates that there was productivity convergence. Industries with a lower productivity ratio (and thus a higher productivity gap) had higher productivity growth, suggesting that the "catching up" effect was more significant than the "learning" effect.

### 3.3.3 Sector Differences

Since trade liberalization allows comparative advantage to shape resource allocation, it is interesting to explore whether its impact varies across industries depending on their factor intensities. Industries relying heavily on abundant factors will face a more favorable economic environment than previously, attracting both domestic and international investment. At the same time, as noted above, other reforms in Latin America have changed the relative attractiveness of particular industries to foreign investment. Multinationals have embarked on or expanded manufacturing operations in Latin America in three broad categories: maquila (labor intensive assembly industries producing exclusively for export, primarily apparel and electronics), concentrated North of Panama; automobile assembly, concentrated in Mexico (for export) and Brazil and Argentina (for Mercosur); and natural resource processing (minerals and agro-industry) in South America, primarily for export (Mortimore, 2000; Reinhardt and Peres, 2000).

The results on the trade variables suggest some differences in impact across the three groupings. While the import coefficient is significant for all three groups, the coefficient on the export variable is significant only for the natural resource intensive industries (NRI).[11] The coefficients on the commercial reform variable are positive and significant for LI (labor intensive) and NRI industries but not for HCI (human capital intensive) industries. In sum, all three trade-related variables are positive and significant only for the NRI sector. For LI industries, import growth and commercial reform are positive and significant, but not export growth, and for HCI, only import growth is significant.

US productivity growth emerges as an important correlate of productivity growth in the HCI and NRI sectors, with a large and significant coefficient in both cases. A one percentage point increase in US productivity growth was associated with a 0.69 (HCI) and a 0.26 (NRI) percentage point increase in productivity growth in the seven Latin American countries. On the other hand, the coefficient for US productivity growth was significantly negative for the LI industries.

Taken together, these results indicate that HCI industries were most affected by international productivity growth, especially when import competition increased. These results are also consistent with the different investment trajectories of these sectors. While HCI and NRI sectors became increasingly dominated by multinationals, the LI industries in South America continued to be dominated by domestic firms, including small and medium enterprises with limited access to investment financing (Peres and Stumpo, 2000; Reinhardt and Peres, 2000).[12] As indicated above, multinationals – especially those oriented towards

[11] This is not surprising, given that NRI is the most export-oriented group. Nevertheless, in the LI and HCI groups, the magnitude of the coefficient is similar to that for the full sample.

[12] The exception for the countries we are studying is Mexico's MNC-dominated, labor intensive maquila sector, which is not included in our analysis.

international markets – are more likely to incorporate new international technological developments.

Our results suggest that the impact of trade opening has varied somewhat by sector. These differences are related both to the factor endowments and market orientation of these sectors, and to the different role that foreign investment has played in each industry. The latter, in turn, has been influenced by a host of factors independent of trade opening itself.

## 4 ASSESSMENT AND POLICY IMPLICATIONS

In this paper we analyzed the impact of trade liberalization on manufacturing productivity growth in seven Latin American countries during 1970–99. The variation among countries and over time in our sample provides a rich base to explore the relationship between trade regime and productivity growth. Our findings suggest some avenues by which trade liberalization may have increased productivity growth for these seven countries.

The results show a significant relationship between increased import competition and productivity growth. This suggests that import competition has forced surviving firms in these countries to be more competitive. Furthermore, the lagged "Commercial Reform" Index was positively and significantly related to productivity growth. This may reflect the positive effect on productivity growth of firms' access to cheaper, higher quality technology imports after liberalization. Nevertheless, we cannot distinguish between the possible avenues for firm-level productivity improvements, nor determine the importance of firm exit as a response to import competition.

Similarly, we also find evidence of a significantly positive association between export growth and productivity growth, although not for the LI and HCI industries separately. The relationship between these two variables is complex, however, as evidenced by our Granger causality tests suggesting substantial two-way causality between export growth and productivity growth in many Latin American industries.

We do not have enough information to determine what underlies the positive effect of exports. It may capture domestic producers' learning of "best practice", as they increase their contacts with foreign trading partners. It may also reflect an increased presence of higher productivity multinationals, however, which is especially the case in the NRI group where export growth was significant.

The increased presence of multinationals in the HCI group may also have contributed to the finding of a large positive impact of international productivity growth in this group in the 1990s. The potentially significant role of multinationals in labor productivity growth suggests a particularly difficult interpretation problem. Since trade liberalization in Latin America happened in the context of broad neo-liberal reforms, it is difficult to separate the impact of trade liberalization from that of other policies, such as stabilization policies, deregulation, and privatization, which may have had significant effects on investment flows to the region. To the extent that these policies were responsible for increased productivity growth through greater multinational investment, we may be overstating the importance of trade liberalization to this growth.

In addition to contemporary domestic policies, international factors were also significant in the region's manufacturing productivity growth. Movements of the technology frontier itself (as proxied by an industry's US productivity growth) had positive spillovers to domestic productivity growth, especially for HCI industries. Our results point to productivity convergence; *i.e.*, productivity growth was smaller in industries where the productivity level had been closer to the frontier in the previous period.

These findings taken together suggest that the Latin American reform package, in the context of increased international investment and rapid global technological progress in some industries, resulted in greater manufacturing labor productivity growth. However, this productivity growth was associated with some disturbing trends in the manufacturing sector's performance (see Table IV). First, while Argentina, Mexico, and Peru registered faster manufactured output growth than in the 1980s, output growth fell in the other four countries, with production stagnant in Brazil and actually declining in Uruguay. Second, compared to the 1980s, manufactured export growth in the 1990s was relatively strong only in Mexico, Peru, and Brazil, but declined in the other four countries. Third, import growth outstripped export growth in all countries, raising the red flag of a growing balance of payments problem. Fourth, compared to the 1980s, there was relatively little productivity catch up with the US. The average productivity level relative to the US (relative productivity) only improved in Argentina and Mexico. It remained more or less the same in Brazil and Colombia, but declined dramatically in Peru and Uruguay.

Finally, manufacturing employment declined significantly in all countries except Peru and Chile, and was stagnant in Mexico. Declining employment is a particular cause of concern. On the one hand, it suggests a declining standard of living for more people, since – on average – the manufacturing sector pays better wages than agriculture and services. On the other hand, it also indicates that the increase in labor productivity growth in the 1990s was partly the result of labor shedding and not of new investment and technology.

Other authors have pointed out that restructuring in the manufacturing sector has increased the importance of natural resource intensive sectors (*e.g.*, Katz and Stumpo, 2001) and of multinationals, and that Latin American countries lag far behind their East Asian counterparts in specialization in high-technology products (*e.g.*, Mortimore and Peres, 2001). Another study has found a significant decline of the machine-tool industry in most Latin American countries (Alcorta, 2000). It is conceivable, therefore, that trade liberalization may have increased productivity growth in the short run, as firms adjusted to new competitive pressures and changing relative prices, but that these same adjustments may have adversely affected the potential for long-run productivity growth of these economies. In the case of the leading reformer, Chile, one recent study has concluded that the cycle of economic growth based on export-oriented investments in the natural resource sector has come to an end (Moguillansky and Bielschowsky, 2000). It is not clear what sectors will emerge to generate continued productivity growth in the future.

If we only looked at the relationship between trade liberalization and productivity growth, ignoring these other trends, then our findings would be compatible with the policy recommendations that governments should liberalize trade in order to increase productivity growth. However, productivity growth is not an end in itself, but a means to higher economic growth and an improved standard of living. And therefore any policy implications derived from this study have to be informed by an understanding of whether these goals have actually been reached. The fact that manufacturing productivity growth in some countries was accompanied by a decline in manufacturing employment and output, by a growing productivity gap with the United States, and by a relative decline in high-technology industries along with a denationalization of many sectors, suggests that there have been some undesirable effects of trade liberalization – or that, at the very least, trade liberalization has not been sufficient to achieve the desired objectives.

What can be done to enhance the potentially positive effects of trade liberalization? As Rodrik (2001, p. 24) puts it, ". . . no country has developed simply by opening itself up to foreign trade and investment. The trick has been to combine the opportunities offered by world markets with a domestic investment and institution-building strategy to stimulate the animal spirits of domestic entrepreneurs". As the region's experience with trade liberalization

has brought many of the aforementioned problems to the fore, increased attention has focused on the need to support domestic entrepreneurs in their attempts to adjust to the new economic environment. Policies are being sought that can enhance firms' competitive capabilities and their ability to successfully absorb new technology. Suggestions include support for research and development, worker training, supplier networks of small and medium enterprises, international marketing assistance, and, more generally, improving educational systems in the region (Ocampo, 1998; Ramos, 2000; Rodrik, 1999).

The exact nature and combination of policies has to be informed by country specific conditions. Yet, in all cases, it will be critical to develop aggressively the human capital base. Latin American middle income countries enroll a much smaller percentage of students of the relevant age group in secondary school.[13] That suggests that deeper learning is much less widely dispersed than in other countries, with a smaller share of workers in command of more basic scientific knowledge helpful in absorbing and applying more advanced technologies. Improvements in human capital broadly defined are in many ways an end in itself, as they expand people's choices and possibilities and enrich their lives. They are also an absolute necessity for future productivity growth and economic growth that provides the much needed creation of gainful employment opportunities.

## References

Alcorta, L. (2000) New economic policies and the diffusion of machine tools in Latin America, *World Development*, Special Issue, **28**(9), 1657–1672.

Arellano, M. and Bond, S. (1991) Some tests of specification for panel data: Monte Carlo evidence and an application of employment equations, *Review of Economic Studies*, **58**(2), 277–297.

Aswicahyono, H. H., Bird, K. and Hill, H. (1996) What happens to industrial structure when countries liberalise? Indonesia since the mid–1980s, *Journal of Development Studies*, **32**(3), 340–363.

Aw, B. *et al.* (1997) Plant-level evidence on productivity differentials, turnover, and exports in Taiwanese manufacturing. Mimeo, Pennsylvania State University.

Bailliu, J. N. (1998) Private capital flows, financial development and economics growth in developing countries. Working Paper, University of California, Santa Cruz.

Bonelli, R. (1992) Growth and productivity in Brazilian industries: impacts of trade orientation, *Journal of Development Economic*, **39**, 85–109.

CEPAL (2000) *PADI*, CD-ROM, Version 3.0. Santiago: CEPAL.

Chuang, Y-C. (1993) Learning by doing, technology gap, and growth. PhD dissertation, Department of Economics, University of Chicago.

Chuang, Y-C. (1996) Identifying the sources of growth in Taiwan's manufacturing industry, *Journal of Development Studies*, **32**(3), 445–463.

Clerides, S. K., Lach, S. and Tybout, J. (1998) Is learning by exporting important? Micro-dynamic evidence from Colombia, Mexico, and Morocco, *Quarterly Journal of Economics*, **103**(3), 903–947.

Edwards, S. (1998) Openness, productivity and growth: what do we really know? *Economic Journal*, **108**, 385–398.

Haddad, M., de Melo, J. and Horton, B. (1996) Morocco, 1984–89: Trade liberalization, exports and industrial performance, In: Roberts, M. J. and Tybout, J. R. (Eds) *Industrial Evolution in Developing Countries: Micro Patterns of Turnover, Productivity and Market Structure*. Washington, DC: Oxford University Press for the World Bank.

IDB (Inter-American Development Bank) (1997) *Economic and Social Progress in Latin America, 1997 Report: Latin America after a Decade of Reforms*. Baltimore, MD: Johns Hopkins University Press.

Katz, J. (2000) Structural change and labor productivity growth in Latin American manufacturing industries 1970–96, in Peres and Reinhardt (eds) *The Microeconomics of the New Economic Model in Latin America, World Development*, Special Issue, **28**(9), 1583–1596.

Katz, J. and Stumpo, G. (2001) Regimenes competitivos sectoriales, productividad y competitividad internacional. Paper presented at the conference "Camino a la competitividad: El nivel meso y microeconomics", CEPAL, Santiago de Chile, March.

[13]In 2000, the mean secondary enrolment rate in Latin American middle income countries was 47 percent compared to 78 percent in other middle income countries. For details regarding country groupings, see Paus (2002).

Leibenstein, H. (1966) Allocative efficiency vs. "X-efficiency", *American Economic Review*, **56**(3), 392–415.
Macario, C. (2000) The behavior of manufacturing firms under the new economic model, *World Development*, Special Issue, **28**(9), 1597–1610.
Moguillansky, G. and Bielschowsky, R. (2000) *Inversion y Reformas Economicas en America Latin*. Mexico: Fondo de Cultura Economics and Cepal.
Morley, S., Machado, R. and Pettinato, S. (1999) *Indexes of Structural Reform in Latin America, Serie Reformas Economicas 12*. Santiago: CEPAL.
Mortimore, M. (2000) Corporate strategies for FDI in the context of Latin America's new economic model, *World Development*, Special Issue, **28**(9), 1611–1626.
Mortimore, M. and Peres, W. (2001) La competitividad internacional de America Latina y el Caribe: Las dimensiones empresarial y sectorial. Paper presented at the conference "Camino a la competitividad: El nivel meso y microeconomics", CEPAL, Santiago de Chile.
Nishimizu, M. and Robinson, S. (1984) Trade policies and productivity change in semi-industrialized countries, *Journal of Development Economics*, **16**, 177–206.
Ocampo, J. A. (1998) Beyond the Washington consensus: An ECLAC perspective, *CEPAL Review*, **66**, 7–28.
Paus, E. (2002) Neo-liberal reforms and productivity growth in Latin America: Challenges for the future. Paper presented at the 3rd European Congress of Latin Americanists, Amsterdam, 3–6 July.
Pavcnik, N. (2000) Trade liberalization, exit, and productivity improvements: Evidence from Chilean plants. NBER Working Paper No. 7852.
Peres, W. and Stumpo, G. (2000) Small and medium-sized manufacturing enterprises in Latin America and the Caribbean under the new economic model, *World Development*, Special Issue, **28**(9), 1643–1656.
Ramos, J. (2000) Policy directions for the new economic model in Latin America, *World Development*, Special Issue, **28**(9), 1703–1717.
Reinhardt, N. and Peres, W. (2000) Latin America's new economic model: Micro responses and economic restructuring, *World Development*, Special Issue, **28**(9), 1543–1566.
Rodriguez, F. and Rodrik, D. (1999) Trade policy and economic growth: A skeptic's guide to the cross-national evidence. NBER Working Paper No. 7081.
Rodrik, D. (1999) *The New Global Economy and Developing countries: Making Openness Work*. Policy Essay 24, Washington, DC: Overseas Development Council.
Rodrik, D. (2001) The global governance of trade as if development really mattered. Background paper for the UNDP, available online at: <http://ksghome.harvard.edu/~drodrik.academic.ksg/papers.html>.
Sjoeholm, F. (1999) Exports, imports, and productivity: results from Indonesian establishment data, *World Development*, **27**(4), 705–715.
Stallings, B. and Peres, W. (2000) *Growth, Employment, and Equity: The Impact of the Economic Reforms in Latin America and the Caribbean*. Washington, DC: Brookings Institution Press.
Tybout, J. (1996) Heterogeneity and productivity growth: Assessing the evidence, In: Roberts, M. J. and Tybout, J. R. (Eds) *Industrial Evolution in Developing Countries Micro Patterns of Turnover, Productivity and Market Structure*. Washington, DC: Oxford University Press for the World Bank.
Tybout, J. (2000) Manufacturing firms in developing countries, *Journal of Economic Literature*, **38**(1), 11–44.
Tybout, J. and Westbrook, M. D. (1995) Trade liberalization and dimensions of efficiency change in Mexican manufacturing industries, *Journal of International Economics*, **39**(1–2), 53–78.
Tybout, J., de Melo, J. and Corbo, V. (1991) The effects of trade reforms on scale and technical efficiency: New evidence from Chile, *Journal of International Economics*, **31**(3–4), 231–250.
Weinhold, D. and Rauch, J. E. (1997) Openness, specialization, and productivity growth in less developed countries. NBER Working Paper No. 6131.
Yean, T. S. (1997) Determinants of productivity growth in the Malaysian manufacturing sector, *ASEAN Economic Bulletin*, **13**(3), 333–343.