JOURNAL OF ECONOMIC DEVELOPMENT 93
Volume 32, Number 2, December 2007

DYNAMIC EMPIRICS OF TRADE OPENNESS AND ECONOMIC GROWTH IN LATIN AMERICA: DO FAST REFORMERS GROW FASTER?

GUSTAVO BARBOZA*

Clarion University of Pennsylvania

This study uses a dynamic model to determine the contribution of openness on output growth in Latin America. Error Correction Model and Phillips and Loretan results prove superior to OLS estimates. First, openness growth does not have a straight positive relationship to productivity growth; i.e., it is not clear whether fast reformers grow faster. Second, there are significant variations between the short run and long run estimates under the ECM but not under the Phillips and Loretan specification. Third, lead effects are present and are strong in magnitude.

Keywords: Economic Growth, Trade Openness, Dynamic Estimates
JEL classification: F1, O3, O4

1. INTRODUCTION

Latin America's economic history from the mid 1800s until the present could be divided into three clear, distinct, and significantly contrasting economic periods. The first period of an export-led growth, from the mid 1800s to the beginning of the 1900s, was characterized by a strong international demand for primary products and raw materials. In the second period, from early-mid 1900s to late 1970s early 1980s, Latin America, sought an inward-looking approach as the vehicle to promote growth from within, in response to continuous declining international conditions, better known as Import Substitution Industrialization. Under ISI economies achieved mixed results; on the one hand output grew at an average rate of about 5% in real terms, while on the other, unsustainable twin deficits developed (fiscal and current account), that in conjunction with the international financial crises of the early 1980s brought the ISI experiment to an end. The third period, from the early 1980s on, recognized the unsustainability of ISI,

* The author wants to thank an anonymous referee for valuable comments which have greatly improved this study. The remaining errors are the author's sole responsibility.

and builds on market-oriented economic reforms that have a strong emphasis on outward looking policies. In this third period, free trade and market economics replace the dominant role once played by the state. Much of the reform process that Latin American countries undertook responded to the unsustainable internal conditions of the economies themselves. World Bank structural adjustment programs and IMF conditionality of stabilization loans play a significant role in the design of the policies in this quest for growth. These programs assume that freer trade and in particular export expansion serve the purpose of foreign exchange generation and promote stabilization. Furthermore export expansion allows for reallocation of resources, technological transfer and development to boost output growth. It is generally agreed that economies open to international trade tend to grow faster than otherwise. (See for instance, David and Loewy (1998), Keller (2002), Grossman & Helpman (1991), Aghion and Howitt (1998), Edwards (1993), and Romer (1990), among others.) Has this been the case of Latin America?

A complete understanding of trade reform and its effects in Latin American economic performance requires inquiring about both the short run and long run effects of trade policy on output growth. In this regard, some pertinent questions are: What have the effects of trade openness been on factor accumulation, productivity and output growth in Latin America? Are there significant differences between the short run and long run effects of trade expansion on output growth and factors' productivity? Do more open economies outperform less open economies? Do fast reforming economies grow faster? What is the record of trade openness reform in the region? Have all Latin American countries move in the same direction and at the same speed? What lessons can be drawn?

This paper aims to determine the relative contributions of capital accumulation and labor growth, and in particular trade openness on per capita income growth in the context of a dynamic setting. To fully capture the short and long term effects of openness on output, this paper uses a dynamic specification of a single neoclassical production function. Close inspection is dedicated to the free trade movement that dominated economic and political thinking in Latin America during the 1980s and 1990s. In this paper we do not attempt to explain the mechanism of how trade openness evolves, but rather we look at the degree of revealed trade openness as the result of profit maximizing economic agents responding to economic incentives.[1] As indicated, our goal is to elucidate whether more and faster trade openness has a positive effect on per capita output growth. For this purpose we focus on modeling output growth as a single equation, paying particular attention to the concept of "revealed openness" (Dowrick and Golley (2004)).

The paper is organized as follows. We first present a simple neoclassical framework to determine factor contributions to output growth in a closed economy. We then

[1] The nature of these incentives is beyond the scope of this study.

augment the model to allow for the effects of openness and overall factor contributions, on per worker output growth. The third component of the study is to perform comparative analysis between three alternative estimation techniques to compare and contrast the static and dynamics aspects of growth. We validate our hypothesis with a sample of twenty Latin American countries for the 1960 to 2000 period, using Penn World Tables and World Bank Economic Indicators Data. We conclude and draw policy recommendations in the last section.

2. GROWTH AND (TRADE) OPENNESS EFFECTS: A SIMPLE STATIC APPROACH

The literature on economic growth is both vast and rich. In particular, based on the productivity framework of the pioneer Solow model, a large effort is devoted to study the impact that export (trade) growth has in per capita output growth (Balassa (1978), Barboza (1997), Mbaku (1989), Kavoussi (1984), Tyler (1981), Moschos (1989), De Gregorio (1992), Ram (1985), Edwards (1992, 1993), Harrison (1996), Krueger (1978), Strauss and Ferris (1996), Miller and Upadhyay (2000), among others). In general, there is significant consensus that export (openness) promotion creates favorable conditions for enhanced economic growth. Whether higher degrees of openness are equivalent to freer trade is still debatable, however. Nevertheless, freer international trade is affirmed to promote growth both directly and indirectly through the effects on investment and overall capital accumulation. Endogenous growth models argue that if trade is to enhance economic growth, further elements, such as, the transfer of technology, generation of economies of scale, learning-by-doing and a greater development of R&D the sector should be considered, i.e., dynamic gains associated with the production process above and beyond the well known static gains of trade (Edwards (1992), Romer (1986, 1990, 1994), Grossman and Helpman (1990, 1994), Keller (2002), Dowrick and Golley (2004), among others). However, the openness-output relationship has been mostly constrained to static specifications and corresponding estimates.

As indicated earlier the underlined assumption underpinning trade openness as a source for growth is the existence of a positive relationship between trade and technological transfer. The literature is vast in this regard. For instance, Grossman & Helpman (1991), argue that international trade in goods may itself be central to the spillover of ideas. Aghion and Howitt (1998, p. 374) argue that developing economies may be able to reverse-engineer the capital goods they import. Ben-David and Loewy (1998) indicate as well, "[t]rade flows facilitate the diffusion of knowledge among countries … [h]eightened trade will, in general, lead to greater diffusion and faster knowledge growth and hence, to faster per capita output growth" (p. 144). It follows that countries with low exposure levels should have a difficult time absorbing technological spillovers from trade.

Harrison (1996) argues "the 'new' growth theories suggest that trade policy affects

long-run growth through its impact on technological change. In these models, openness to trade … affects a country's specialization in research-intensive production." (p. 419-420). Keller (2002) concurs indicating that "[C]ountries that have adopted relatively open trade regimes have often grown substantially faster than more protectionist countries." (p. 5) According to Keller (2002) "If trade is an important mechanism of technology transmission, research and development subsidies that induce technical progress will affect productivity largely according to the input-output and foreign trade-structure of the economy." (p. 5)

In studying the role of trade on economic growth, Rivera-Batiz and Romer (1991), and Grossman and Helpman (1991), among others, argue that participation in a larger world economy may speed a nation's growth because of access to a larger technical knowledge and it may mitigate redundancy in industrial research. Ben-David and Loewy (1998) coincide as they state "that trade between countries acts as a conduit for the dissemination of knowledge" (p. 147). Ben-David and Loewy (1998) are more explicit as to indicate that "[T]he more open an economy, the greater the competitive pressures on it, and the greater the need for it to incorporate foreign knowledge into its production processes … trade flows between countries facilitate the diffusion of knowledge and spur the growth process." (p. 165-166).

In a highly related issue, Grossman & Helpman (1990) point out that "[T]rade environment might influence the rate of accumulation of human capital or the rate at which a technologically lagging (less developed) country adopts for local use the existent off-the-shelf techniques of production." (p. 184). This point is further clarified by Edwards (1993) when stating "Grossman & Helpman (1991), and Edwards (1992), have emphasized the role of freer trade in generating technological progress." (p. 1389). Edwards (1993) continues saying "A higher degree of openness allows smaller countries to absorb technology developed in the advanced nations at a faster rate and thus to grow in equilibrium, more rapid than with a lower degree of openness" (p. 1389).

The Model

Let us follow the formulation that previous studies have used[2] and use a simple production function to delineate factors' contribution to economic growth as follows:

$$Q_{it} = f\left(K_{it}, L_{it}\right), \tag{1}$$

where Q_{it} is the real Gross Domestic Product, K_{it} is the capital stock, and L_{it} is the labor force for country i on time t.

Totally differentiating with respect to time, and dividing through by Equation (1), yields:

[2] We follow a similar approach as presented in Feder (1982), De Gregorio (1992), Mbaku (1989), Kavoussi (1984), Ram (1985), Moschos (1989), Knight *et al.* (1993), Tyler (1981), and Moran (1983).

$$y_{i,t} = \alpha + \beta k_{i,t} + \delta l_{i,t}\,, \tag{2}$$

where $y_{i,t}$ is the rate of growth of output per effective unit of labor,[3] $k_{i,t}$ is the rate of growth of capital stock, $l_{i,t}$ is the rate of growth of the labor force, and β, and δ are the elasticities of output with respect to capital, and labor respectively, and α is the growth rate of total factor productivity. By approximating the rate of growth of the capital stock by the investment-output ratio (Ram (1985), Feder (1982), and Mbaku (1989), among others) times the rate of growth of the capital stock, and replacing the change in the capital stock with the investment rate, *I*, we obtain,

$$y_{i,t} = \alpha + \lambda \frac{I_{i,t}}{Q_{i,t}} + \delta l_{i,t}\,, \tag{3}$$

where λ is the marginal physical output of capital. Equation (3) corresponds to the close economy model. To test our hypothesis of the effects of trade openness on output growth, we expand the model in (3), under the assumption that openness enables the exploitation of economies of scale, acts as a mechanism to transfer technology, promotes reallocation of resources according to comparative advantage, allows for greater capacity utilization, and increases employment in labor surplus countries (see as indicated earlier Grossman and Helpman (1990, 1991, 1994), Aghion and Howitt (1998), Harrison (1996), Edwards (1992, 1993), Ben-David and Loewy (1998), among others). In other words, trade openness (*x*) acts as mechanism for technological change. Technological change can now be approximated by $\alpha = \alpha_0 + f(x)$. The resulting equation is:

$$y_{i,t} = \alpha_0 + \lambda \frac{I_{i,t}}{Q_{i,t}} + \delta l_{i,t} + \psi x_{i,t}\,, \tag{4}$$

where $x_{i,t}$ is the rate of growth of openness and it is now assumed that the rate of technological change is a linear function of the openness growth rate, and expressed by ψ. The remaining unexplained portion of technological change (total factor productivity) is captured by α_0 as before. Both Equations (3) and (4) are static specifications and conforms the first set of estimates, as one can see later. Expected parameters signs are $\lambda > 0$, $\delta < 0$, and $\psi > 0$; increases in capital per worker results in increased labor productivity, holding capital constant adding more workers results in

[3] The specification of the model derived in Equation 2 corresponds to the derivation of the Solow model which expresses per capita income in terms of effective units of labor, where effective units of labor are defined as labor times the existent level of technology. For a complete derivation see Solow (1957), Mankiw, Romer and Weil (1992), among others.

decreased labor productivity, and increases in the degree of openness are expected to increase the overall productivity and thus have a positive effect on output growth.

3. DYNAMIC GROWTH EFFECTS

More recent concerns in the estimation of growth models, such as the one presented in (4), highlight on the inclusion of a dynamic specification to account for spillover effects that are generated through the investment process, policy reforms and the promotion of international trade (Francois, Nordström, and Shiells (1996), and Strauss and Ferris (1996)). For instance, Romer (1986) asserts that there are investment spillovers that are better capture in a dynamic framework. Harrison (1996) indicates that "Static trade model do suggest that movements towards openness can temporarily increase the rate of growth due to short term gains from the reallocation of resources, which would imply a positive relationship between *change* in openness and GDP growth. Recent efforts to model the impact of openness in a dynamic framework predict that both levels and changes in openness can have a long run impact on growth" (p. 435)

Equation (4) is static, and therefore, omits to consider the possible dynamic gains derived from the investment process and through the learning-by-doing and technological transfer involved with trade openness promotion policies.

To include the dynamic properties outlined above, Equation (4) is rewritten following the analysis of Strauss and Ferris (1996) based on Phillips and Loretan (1991). The result is:

$$Y_{i,t} = \alpha_0 + \alpha_1 X_{i,t} + \alpha_2 X_{i,t-1} + \alpha_3 Y_{i,t-1} + e_{i,t}\,, \tag{5}$$

where X_t is the matrix of explanatory variables as before. Furthermore, output in time t is now a function of X_{t-1} and Y_{t-1}. Following Hendry *et al.* (1984), and Strauss and Ferris (1996), an Error Correction Model (ECM) is constructed from (5) by subtracting Y_{t-1} from both sides and rearranging in terms of X_{t-1} under the assumption, $\alpha_2 = 1 - \alpha_3 - \alpha_1$. The resulting ECM is:

$$DY_{i,t} = \beta_0 + \beta_1 DX_{i,t} + \beta_2\left(Y_{i,t-1} - \beta_3 X_{i,t-1}\right) + e_{i,t}\,, \tag{6}$$

where D represents the difference function,[4] β_1 corresponds to the short-run parameter,

[4] The difference function, or difference operator as named by Strauss and Ferris is equal to $DY_t = (Y_t - Y_{t-1})$

$\beta_3 = 1$, therefore $\frac{\alpha_1}{1-\alpha_3}$ indicates the long-run effects, and β_2 is defined as the adjustment speed at which disequilibrium are removed from the economy (Hendry *et al.* (1984)).[5] For instance, if $\beta_2 = 0.5$ transition to equilibrium shall take 2 periods, and so on. Following Hendry *et al.* (1984), Strauss and Ferris (1996) argue that the ECM is preferred to the OLS simple model because it allows for the short-run and long-run differentiation while still avoiding the collinearity between X_t and X_{t-1}. However, in terms of the empirical estimation of the ECM it is easier to express the model without imposing any restriction on the parameters.[6] Wickens and Breusch (1988) argue that the following equation yields estimates of the long-run and short-run dynamics while providing a simpler estimation procedure. Thus, let us express equation (6) in terms of $Y_{i,t}$ as follows:[7]

$$Y_{i,t} = \phi_1 DY_{i,t-1} + \theta X_{i,t} - \gamma_1 DX_{i,t} + \mu_{i,t}. \tag{7}$$

In Equation (7) the estimate for ϕ_1 indicates the speed of adjustment from one equilibrium situation to another, i.e., this is the convergence parameter which indicates how long it takes to remove disequilibrium situations. The long-run parameters are indicated by the vector of parameter included in θ. Finally, the short-run estimates are incorporated in the vector of coefficients represented by γ_1. Therefore, Equation (7) becomes the second approach this study estimates.

The third approach is defined by Phillips and Loretan (1991)[8] (PL) following the initial specification of Wickens and Breusch (1988) as indicated in Equation (7). To include a feedback process and to obtain superior asymptotic sampling properties Phillips and Loretan (1991) modified the Wickens and Breusch (1988) model by including a lead variable and by substituting $DY_{i,t-1}$ for $\left(Y_{i,t-1} - \lambda X_{i,t-1}\right)$, based on asymptotic theory (Strauss and Ferris (1996)).[9] The Phillips and Loretan model is thus:

[5] The coefficient β_2 is known as the ECM parameter, or the dynamic component of the productivity and growth model.

[6] This is especially true for the case of $\beta_3 = 1$.

[7] The specification of the model on Equation 8 is taken from Wickens and Breusch (1988) p. 193.

[8] Phillips and Loretan (1991) indicate that their approach "seek out a tentatively adequate single-equation specification that meets the following criteria …: (i) data coherency, (ii) valid conditioning, (iii) encompassing, (iv) theory compatibility, (v) parsimonious, orthogonal decision variables, (vi) parameter constancy." (p. 413).

[9] For the complete derivation see Phillips and Loretan (1991) or Strauss and Ferris (1996, p.198).

$$Y_{i,t} = \omega_0 + \omega_1 X_{i,t} + \omega_2 DX_{i,t-1} + \omega_3 \left(Y_{i,t-1} - \omega_1 X_{i,t-1}\right) + \omega_4 DX_{i,t+1} + e_{i,t}\,. \quad (8)$$

The interpretation of ω_i coefficients in (8) is as follows. ω_1 is the long-run estimate, ω_2 reflect the long-run lagged parameter, ω_3 is the speed of adjustment and represent the ECM parameter (dynamic specification) and ω_4 correspond to the lead estimate.[10] We will estimate both (7) and (8) for the closed and open economy scenarios. Equation (8) is estimated using a non-linear least squares.

Interpretation of the static OLS estimates is straightforward and follows convention. However, static estimates conceal relevant information that only becomes available through dynamic estimates. Interpreting the coefficients of both the ECM (7) and the Phillips and Loretan (8) models brings additional information that is not feasible to obtain from the static counterpart. In this regard, one can argue that if the short run and long parameters are not significant different from each other, then the economy is characterized by a process of rather fast integration of shocks. Thus, if long run parameters are larger in absolute value relative to the short run, then the economy adjusts slowly to changes in economic conditions, and vice versa. For instance, if long run estimates of openness are larger than the short run counterpart then one can argue that the dynamic gains derived from trade openness (technological transfer and development) are more important than the short run, comparative advantage, gains derived from resource allocation along the lines of specialization.

For the ECM and the Phillips and Loretan, the dynamic component serves as an indication of the speed of adjustment to equilibrium. Low values on the ECM coefficient indicate that the economy is slow in dissipating shocks. Furthermore, the sign of the coefficient becomes relevant as it allows the researcher to determine how equilibrium is restored. If the ECM coefficient is negative, then the economy converges from above. In other words, in response to a shock the economy overshoots its productivity level and thus convergence to the steady state productivity level must occur from above. Finally the introduction of leads in the Phillips and Loretan provides the necessary elements to determine if there exists a feedback process or not.

4. DATA AND SAMPLE

This study uses data from the Penn World Tables 6.1 and from the World Bank Economic Indicators for a sample of twenty Latin American countries for the period 1950 to 2000.[11] We use panel data to fully capture short run and long-run effects in the

[10] The lead variables are included, according to Phillips and Loretan, to increase estimator efficiency, unbiasdness and for inference.

[11] The complete set of data is available from the authors upon written request.

context of a panel analysis. Our data is expressed in rates of growth. Annual rates of growth are computed for the real per effective worker Gross Domestic Product, the real investment-output ratio, the labor force,[12] and the degree of openness measured as the ratio of exports plus imports to GDP per worker. Rates of growth are preferred to levels as it makes comparison across countries more meaningful and guarantees the stationarity of the data.

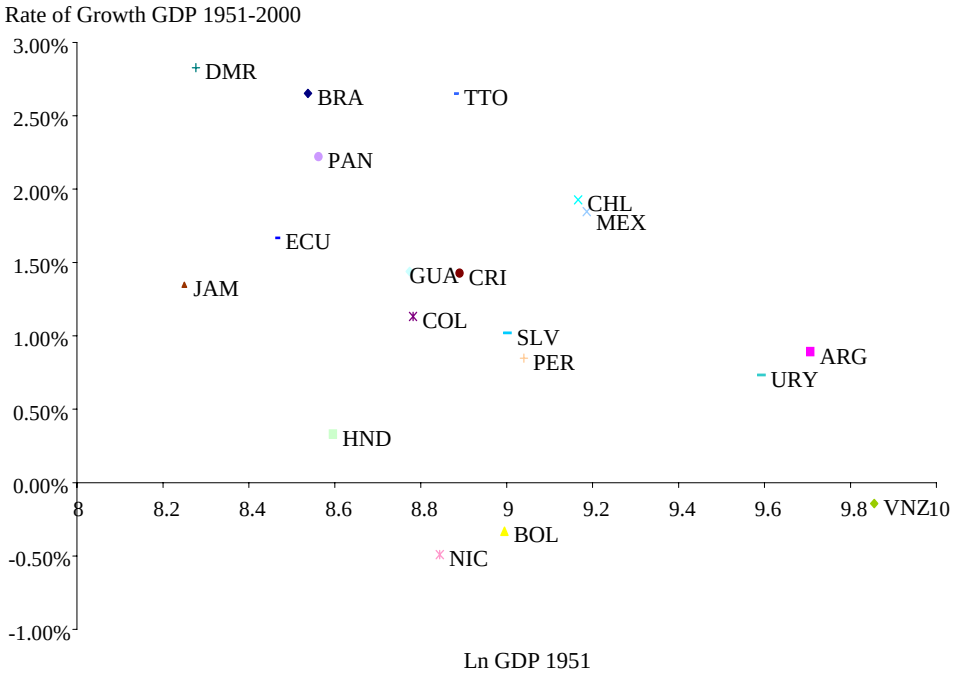

Figure 1. Unconditional Convergence

[12] Labor force data is available from 1960 on.

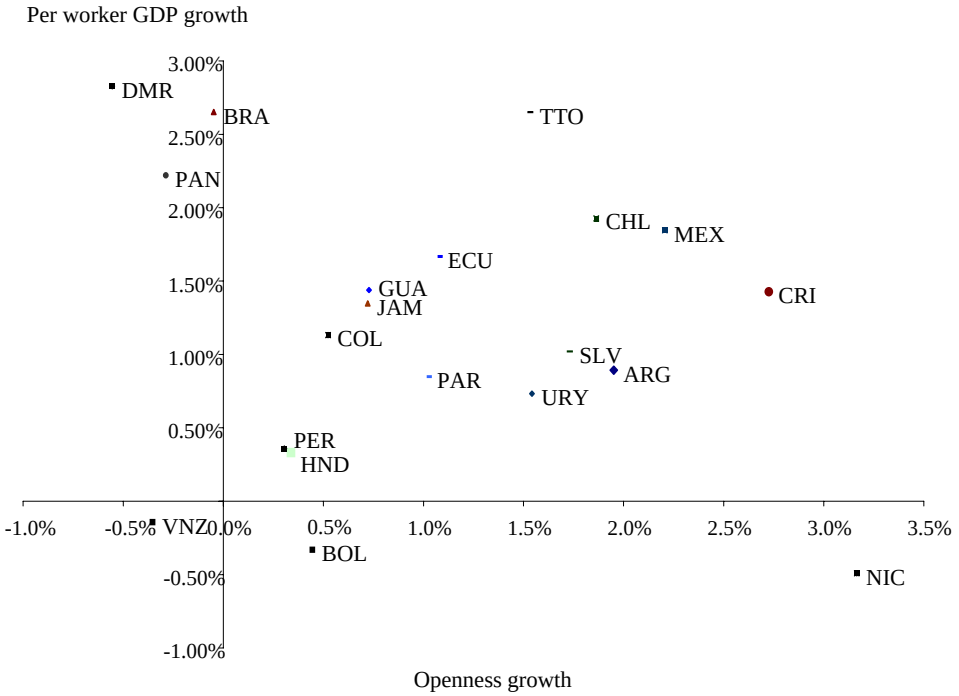

Figure 2. Per Capita GDP Growth and Growth in Degree of Openness 1951-2000

A close inspection of the data as indicated in Figure 1 shows the existence of some unconditional convergence among the Latin American countries on our sample. Nicaragua, Bolivia and Venezuela are outliers as these three countries show a negative average rate of growth of per worker output during the period 1951-2000. On the other hand, from Figure 2 one can glimpse some evidence indicating that countries reforming the fastest on average tend to grow the fastest as well. However, this evidence is relatively fragile as three of the fastest growing countries actually display a negative rate of growth on the degree of openness (Dominican Republic, Panama, and Brazil). Nicaragua, despite the fact of being the country that reforms the fastest, presents a negative rate of growth on output per worker. This same situation is confirmed in Figure 3, where there exists somehow conflicting information. For a sub sample of countries a higher absolute degree of change in openness results in faster per worker growth. This positive evidence is counterbalanced by other countries that present a significant increased rate of output (higher than the average of the remaining countries), yet with an absolute decline in the degree of openness, i.e., after reforming these countries, namely Dominican Republic, Panama, and Brazil, grew faster. In this analysis we assume that one dollar of exports is equivalent to one more dollar of imports in terms of growth

promotion. We recognize that there could be significant differences embodied in the nature of the good or service imported or exported in terms of their relative contributions to technological development and transfer of ideas. These differences, in turn, should manifest themselves in unique ways relatively to their contributions to output growth. However, export and import diversification effects on output growth are beyond the scope of this paper.

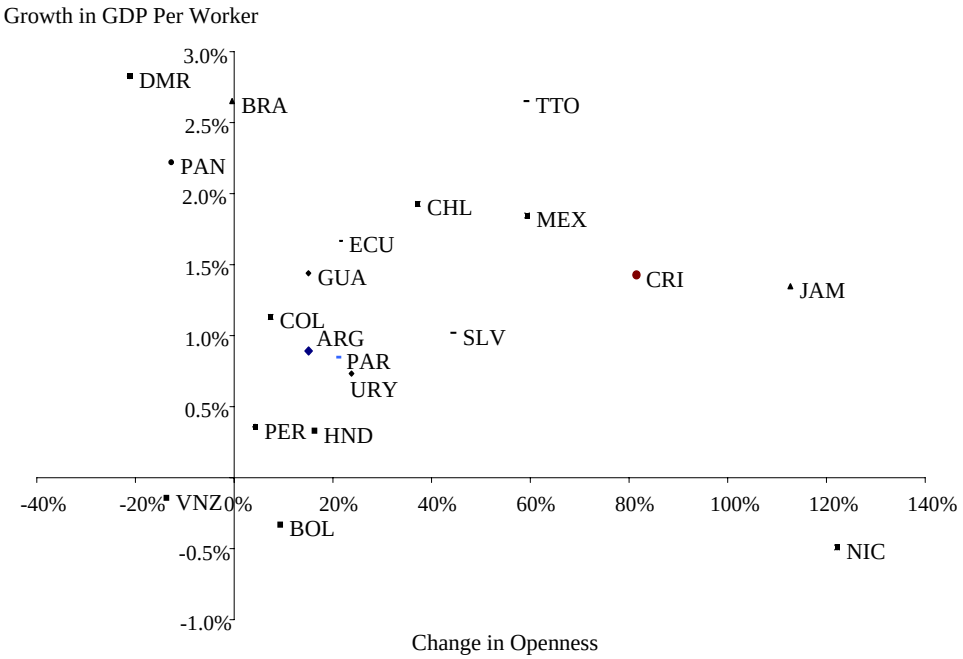

Figure 3. Change in Openness and Growth in GDP per Worker 1951-2000

To empirically test our hypothesis this paper estimates the models under the static POOLED (longitudinal), the dynamic Error Correction Model, and dynamic Phillips and Loretan model. The POOLED estimation consists of a Generalized Least Square estimation that accounts for the existence of heteroskedasticity across cross sections. The ECM introduces the possibility to account for dynamic estimates of the short-run and long-run parameters, and the speed of adjustment, resulting in more efficient estimates and a parsimonious interpretation (Phillips and Loretan, 1991, p. 420). Finally, the Phillips and Loretan dynamic specification expands on the ECM by including lead indicators and thus "produce an asymptotically efficient estimator of the explanatory variables" (PL, p. 424). For each of the alternative estimation procedure, two different scenarios are estimated, one for the close economy and one for the open economy. The

two different estimations will allow us to determine the relative contribution of openness to output growth while controlling for other variables. Results are reported in Tables 1-3. All our estimations are conducted using rates of growth.

5. DISCUSSING THE FINDINGS

Table 1. Static EGLS Estimates with Real GDP per Worker Growth as Independent Variable 1960-2000

	Closed	Open
Constant	0.0206	0.0207
	(0.0001)	(0.0001)
Investment/GDP	0.0229	0.0220
	(0.0014)	(0.0032)
Labor Force	-0.3467	-0.3538
	(0.0532)	(0.0489)
Openness		0.0035
		(0.8429)
Adjusted R^2	0.0214	0.0198
No. of Observations	800	800
DW	1.3471	1.3506

Note: Values in parenthesis are p-values.

Before we proceed to discuss our findings, let us review some of the existence empirical evidence on openness. In general most researchers find support to the hypothesis that trade openness affects output positively.[13] It is relevant to keep in mind that different studies use different measures of openness. Sachs and Warner (1995) state that open economies experienced faster growth. Frankel and Romer (1999) indicate that increases in trade integration results in higher levels of income per person. Strauss and Ferris (1996) report for the most part a positive association between openness and growth. Yanikkaya (2003) reports that "Consistent with a number of empirical studies as reviewed in Harrison (1996), our results support the hypothesis that countries with higher trade shares are likely to grow faster than other countries." (p. 69). Harrison (1996) also indicates, referring to Quah and Rauch (1990), that "using trade shares find that most of the observed positive relationship between openness and growth is due to short-run cyclical fluctuations." (Harrison 1996, p. 434). In a study for Latin America,

[13] Export growth has been found to affect output growth positively as in Balassa (1978), Barboza (1997), Tyler (1981), Ram (1985), Feder (1982), Kavoussi (1984), among others.

Easterly, Loayza and Montiel (1995), find the existence of a strong and highly significant relationship between openness and output growth. In addition, ELM argue that "The reform process in Latin America has still not brought openness to the levels realized in East Asia". (p. 15) Rodríguez and Sachs (1999) however, indicate that a possible negative relationship between trade and growth spurs precisely because of natural resource abundance. They assert that "[I]t has been suggested that greater resource abundance can lead economies to shift away from competitive manufacturing sectors in which many externalities necessary for growth are generated [see models in Sachs and Warner (1995) and Matsuyama (1992)]…[r]esource-abundant economies grow more slowly precisely because they have an unsustainably high level of income." (p. 277-278)

Table 1 presents the EGLS static estimations for the closed and open economy models. The results are within convention as expected; capital accumulation is positive and statistically significant, labor force is negative and significant, and trade openness is positive yet not statistically significant. In addition, the static estimations, both closed and open models, report the existence of autocorrelation as indicated by low DW statistics. The introduction of trade openness on Model 2 does not translate on significant changes in the investment and labor force estimates. In this regard, economies opening up to international trade faster are not performing significantly better than those that do not. This result could reflect at least two forces working on opposite directions. First, not all countries are reforming at the same speed and in the same direction. And secondly, trade openness reform may not actually imply faster openness. (See Figure 2-3.)

Table 2. ECM Estimation Results with Real GDP per Worker Growth as Independent Variable 1960-2000

	Closed	Open
Constant	0.0192	0.0187
	0.0001	(0.0002)
Short Run		
Investment/GDP	-0.0290	-0.0253
	(0.0000)	(0.0000)
Labor Force	0.6161	0.6235
	(0.3660)	(0.3505)
Openness		-0.0263
		(0.1128)
Long Run		
Investment/GDP	0.0474	0.0421
	(0.0004)	(0.0005)
Labor Force	-0.3162	-0.3168
	(0.0298)	(0.0317)
Openness		0.0332
		(0.2198)
Dynamics		
ECM	0.1333	0.1292
	(0.0010)	(0.0010)
Adjusted R^2	0.0625	0.0620
No Observations	780	780
DW	1.5320	1.5406

Note: Values in parenthesis are p-values.

Results of the ECM are in Table 2. Several elements are worth exploring on these estimations. The dynamic results expose a wealth of effects that are obscure in the static estimations. The availability of further details on the relationship between capital, labor and openness in productivity should provide a better setting for analysis and prediction. First there is a clear difference between the short run and long run absolute value of the parameters, where long run is consistently higher than the correspondent short run. Second, all parameters have the expected signs, despite the fact that some are not statistically significant. We find that trade openness has as large an effect on output growth as capital accumulation. This fact is more remarkable as the introduction of openness does not result in a significant change in capital contribution to output. This is true not only for the long run parameters but also for the correspondent short run estimates. In this regard, the long run estimates for capital accumulation and openness are much larger than the short run estimates. The speed of adjustment i.e., the transition to equilibrium takes about 7 to 8 years.

Table 3. Phillips and Loretan Estimation Results with Real GDP per Worker Growth as Independent Variable 1960-2000

	Closed	Open
Constant	0.0095	0.0143
	(0.0485)	(0.0114)
Long Run-Lagged		
Investment/GDP	0.0037	0.0047
	(0.5595)	(0.4708)
Labor Force	0.7679	0.8062
	(0.2022)	(0.1778)
Openness		-0.0491
		(0.0033)
Long Run		
Investment/GDP	0.0437	0.0489
	(0.0000)	(0.0000)
Labor Force	-0.4265	-0.1361
	(0.3537)	(0.1869)
Openness		-0.0438
		(0.0642)
Leads		
Investment/GDP	0.0364	0.0395
	(0.0000)	(0.0000)
Labor Force	1.3745	1.2956
	(0.023)	(0.0303)
Openness		-0.0199
		(0.2301)
Dynamic		
Investment/GDP	-0.3392	-0.2704
	(0.0923)	(0.156)
Labor Force	0.6443	-1.6431
	(0.0014)	(0.2239)
Openness		2.2095
		(0.0965)
Adjusted R^2	0.1485	0.1717
No Observations	740	740
DW	2.0272	2.0111

Note: Values in parenthesis are p-values.

We also find that the ECM estimates outperform the OLS estimates for all parameters both in terms of statistically significance, but more importantly in terms of economic significance. Under the ECM the relative contribution of capital to output is significant in the short and long run, with a combined effect of about 7%, i.e., for every 10% increase in investment output should grow about 0.7%. Furthermore, the contribution of openness to output growth is significantly higher under ECM compared to OLS. Labor force growth affects per worker output growth negatively as expected and has about the same magnitude in the long run under OLS and ECM, and it is not statistically significant in the short run ECM estimates. Finally under ECM most autocorrelation has been removed. All in all the ECM is preferred to the OLS estimates. Clearly OLS estimates yield results that could bias policy recommendations and thus delay the positive benefits of reform, in particular openness. OLS results are biased and thus underestimate the effects of investment and openness on productivity.

The final estimation corresponds to the augmented dynamic model specified by Phillips and Loretan (Table 3). In the PL estimations several elements are worth mentioning. In the first place we find that the long-run lagged parameters are not statistically significant, with the exception of openness which carries a negative sign. Strauss and Ferris (1996) report similar results in this department. It is apparent that increases in openness in the short run translate in losses in productivity. This of course is a puzzling result as it may indicate that faster openness not necessarily translates into faster growth. In other words despite the fact that more openness may increase the level of output it does not imply faster growth; on the contrary it propels the economy into a loss of productivity in the short run that is similar to that of the long run, as we will discover next. Additionally the negative coefficient could be interpreted as trade openness creating an overshooting effect on output growth that results in convergence to the long run growth from above. In terms of capital and labor growth, the insignificant coefficients tend to indicate that short run perturbations on both factors are not manifesting themselves as permanent effects on productivity gains.

As we turn to the long run parameters, we observe that the investment estimate is in line with the theoretical prediction, positive and significant. This estimate is also larger than the one corresponding to the short run, thus, in the long run; changes in the rate of accumulation of capital have a more permanent effect on productivity gains. It is worth pointing out to the fact that long run estimates of capital, under the ECM and the PL, are very similar in magnitude adding to the robustness of this estimate. Furthermore, the investment coefficients increase when we estimate the open economy model in comparison to the closed economy version, confirming the expected gains on capital productivity associated with larger degrees of openness. Labor force is negative as expected, but only marginally significant at the 20% level, much in line with expectations.

The second interesting finding from the long run estimates comes out of openness, which is negative and significant. We continue to wonder, what is the correct expected sign for openness and what is the meaning of a negative and significant sign?

As we explore the openness estimates, one observes that the short run and long run are almost identical in magnitude, indicating that the market materializes the effects of openness on output rather quick. This result is particularly interesting for two reasons. First, because of the negativeness of the relationship between openness and productivity, and secondly the lack of long run productivity gains to be derived from the openness process, or at least the lack of difference between static gains of trade openness (comparative advantage of reallocation of resources), and dynamic gains derived from technological development and transfer usually associated with more open economies in the long run. These same results were confirmed in the ECM short run and long run estimates, which of course points out to the robustness of the results.

Lead estimates unveil the last component of the PL dynamic estimates. Investment is positive and statistically significant indicating the presence of feedback effects in productivity. These same results are found for labor force, which are highly significant and large in magnitude. For labor force and capital accumulation, feedback effects could be interpreted as, for instance, in the presence of negative shocks in the economy, investment will decline and unemployment would rise sharply; both elements are in line with the empirical evidence in the region. On the other hand, if economy wide expectations are positive, we shall expect more investment to take place and marked declines in unemployment. The investment lead indicator is about 80% of the long run value. For openness, we observe a negative lead indicator, i.e., negative shocks in the economy result in increased revealed openness.

6. CONCLUSIONS

As we look back to our introductory remarks, we now have a study that sheds light in understanding the role of openness on economic growth in the context of a dynamic setting. In general, dynamic estimates provide a wealth of information that is not present in the static estimations. This gained learning into the relationship of openness, capital accumulation and labor force growth on productivity, unveiled a more appropriate set of tools for public policy analysis. Based on our sample and considering the large variations in economic performance and openness reforms in Latin America in the last four decades, our estimates confirm the following general results. First, openness does not have a straight positive relationship to productivity growth. Second, there are significant variations between the short run and long run estimates under the ECM but not under the Phillips and Loretan specification. This could indicate the presence of marked differences between comparative advantage (short run) gains from openness and gains from technological transfer and development (long run). More research is needed in this regard. Third, lead effects are present and are strong in magnitude. Fourth, physical capital accounts consistently throughout all estimations to output growth both in the short-run and long-run. Under the PL, physical capital contribution to growth is enhanced by trade expansion.

Both the ECM and the Phillips and Loretan models outperform the correspondent OLS model. The main differences between the static and dynamic specifications are as follows: i) dynamic models explain a larger proportion of per capita output growth variation as indicated by larger R^2; ii) dynamic ECM and PL specifications yield larger coefficient values for the capital stock than the correspondent static estimates which may have significant and important implications for policy analysis in developing countries; and iii) dynamic specifications allow to capture the long-run effects of investment and trade promotion (technology transfer and economies of scale) on physical capital productivity, which are underestimated in the static OLS estimates. Consistently, the dynamic specification provides a more appropriate determination of productivity estimates than the static estimations, since the former includes lagged, long-run, lead estimates and a dynamic adjustment factor.

REFERENCES

Aghion, P., and P. Howitt (1998), *Endogenous Growth Theory*, The MIT Press.

Balassa, Bela (1978), "Exports and Economic Growth: Further Evidence," *Journal of Development Economics*, 5, 181-189.

Barboza, Gustavo (1997), "Productividad de los Factores y Crecimiento Económico en Latinoamérica," *Revista de Ciencias Económicas*, XVII, 1, Universidad de Costa Rica.

Ben-David, Dan, and M. Loewy (1998), "Free Trade, Growth and Convergence," *Journal of Economic Growth*, 3, 143-170.

De Gregorio, José (1992), "Economic Growth in Latin America," *Journal of Development Economics*, 39, 59-84.

Dowrick, Steve, and J. Golley (2004), "Trade Openness and Growth: Who Benefits?" *Oxford Review of Economic Policy*, 20(1), 38-56.

Edwards, Sebastian (1993), "Openness, Trade Liberalization, and Growth in Developing Countries," *Journal of Economic Literature*, XXXI, 1358-1393.

_____ (1992), "Trade Orientation, Distortions and Growth in Developing Countries," *Journal of Development Economics*, 39, 31-57.

Easterly, William, N. Loayza, and P. Montiel (1995), "Has Latin America's Post Reform Growth been Disappointing?" Policy, Research Working Paper, Manuscript.

Feder, Gershon (1982), "On Exports and Economic Growth," *Journal of Development Economics*, 12, 59-73.

Francois, Joseph, H. Nordström, and C. Shiells (1996), *Transition Dynamics and Trade Policy Reform in Developing Countries*, World Trade Organization, RD-96-005.

Frankel, Jeffrey, and D. Romer (1999), "Does Trade Cause Growth?" *The American*

Economic Review, 89(3), 379-399.

Grossman, Gene, and E. Helpman (1990), "Comparative Advantage and Long-Run Growth," *The American Economic Review*, 80(4), 796-815.

_____ (1991), "Trade, knowledge spillovers and growth," *European Economic Review*, 35, 517-526.

Grossman, Gene, and E. Helpman (1994), "Endogenous Innovation in the Theory of Growth," *Journal of Economic Perspective*, 8(1), 23-44.

Harrison, Ann (1996), "Openness and growth: A time-series, cross-country analysis for developing countries," *Journal of Development Economics*, 48, 419-447.

Hendry, D., A. Pagan, and J. Sargan (1984), "Dynamic Specification," in Z. Grichles, and M. Intrilagator ed., *Handbook of Econometrics*, 1689-1763.

Kavoussi, Rostam M. (1984), "Export Expansion and Economic Growth: Further Empirical Evidence," *Journal of Development Economics*, 14, 241-250.

Keller, Wolfgang (2002), "Trade and the Transmission of Technology," *Journal of Economic Growth*, 7, 5-24.

Knight, Malcom, N. Loayza, and D. Villanueva (1993), "Testing the Neoclassical Theory of Economic Growth: A Panel Data Approach," IMF Staff Papers, 40, 512-541.

Mankiw, Gregory, D. Romer, and D. Weil (1992), "A Contribution to the Empirics of Economic Growth," *Quarterly Journal of Economics*, 107, 407-437.

Mbaku, John M. (1989), "Export Growth and Economic Performance in Developing Countries : Further Evidence from Africa," *Journal of Economic Development*, 14, 127-142.

Miller, Stephen, and M. Upadhyay (2000), "The Effects of openness, trade orientation, and human capital on total factor productivity," *Journal of Development Economics*, 63, 399-423.

Moran, Cristián (1983), "Export Fluctuations and Economic Growth: An Empirical Analysis," *Journal of Development Economics*, 12, 195-218.

Moschos, Demetrios (1989), "Export Expansion, Growth and the Level of Economic Development: An Empirical Analysis," *Journal of Development Economics*, 30, 93-102.

Penn World Tables Mark 6.1 (2003).

Phillips, P., and M. Loretan (1991), "Estimating Long-Run Economics Equilibria," *Review of Economic Studies*, 58, 407-436.

Quah, D., and Rauch (1990), "Openness and the Rate of Economic Growth," MIT Manuscript.

Ram, Rati (1985), "Exports and Economic Growth: Some Additional Evidence," *Economic Development and Cultural Change*, 33, 415-425.

Rodríguez, Francisco, and J. Sachs (1999), "Why Do Resource-Abundant Economies Grow More Slowly?" *Journal of Economic Growth*, 4, 277-303.

Romer, Paul (1986), "Increasing Returns and Long-Run Growth," *Journal of Political Economy*, 94(5), 1002-1037.

_____ (1990), "Endogenous Technological Change," *Journal of Political Economy*, 98(5-2), S71-S102.

_____ (1994), "The Origins of Endogenous Growth," *Journal of Economic Perspectives*, 8(1), 3-22.

Sachs, Jeffrey, and A. Warner (1997), "Sources of Slow Growth in African Economies," *Journal of African Economies*, 6(3), 335-376.

Solow, Robert (1957), "Technical Change and the Aggregate Production Function," *Review of Economics and Statistics*, 39, 312-320.

Strauss, Jack, and M. Ferris (1996), "A Dynamic Estimation of World Productivity Growth," *Applied Economics*, 28, 195-202.

Tyler, William G. (1981), "Growth and Export Expansion in Developing Countries: Some Empirical Evidence," *Journal of Development Economics*, 9, 121-130.

Wickens, M., and Breusch, T. (1988), "Dynamic Specification, the Long-Run and the Estimation of Transformed Regression Models," *Economic Journal*, 98, 189-205.

World Bank (2002), *World Economic Indicators 2002*, CD Dataset.

Yanikkaya, Halit (2003), "Trade openness and economic growth: a cross-country empirical investigation," *Journal of Economic Development*, 72, 57-89.

Mailing Address: Clarion University of Pennsylvania, 305 Still Hall, Clarion, PA, 16214.
E-mail: gbarboza@clarion.edu

Manuscript received March 2006; final revision received July 2007.