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Economic Growth and the Balance-of-Payments Constraint in Latin America

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Introduction

This paper examines the relationship between economic growth and the trade balance, based on the balance-of-payments-constrained growth model, originally developed by Thirlwall (1979) and McCombie & Thirlwall (1994). Empirical tests of this model are implemented for a number of Latin American economies. One of the main objective is to estimate the balance-of-payments equilibrium long-run growth rates, as determined by Thirlwall's Law, and to investigate whether or not the estimated growth rates are close to the actual growth rates. This is accomplished by using econometric techniques, such as cointegration analysis of a VAR (Vector Autoregressive) specification and the estimation of the income elasticities of imports.

The econometric evidence regarding the validation of Thirlwall's Law in Latin America suggests that even though there are different periods of external adjustment, it has not been possible to reject the main proposition

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of Thirlwall's Law. In other words, no single economy is immune from its external sector constraint. Our approach suggests that Latin American economies need to implement significant changes in their specialization of production if the goal is to achieve sustainable long-run growth rates, which requires an increase in the growth rate of exports together with lowering the income elasticity of the demand for imports.

The paper is structured in five sections. Section one develops a review of the literature on theoretical grounds regarding growth, trade and external restrictions. Section two address the balance-of-payments constrained (Keynesian) growth model originally developed by Thirlwall (1979). The third section presents a brief review of empirical results. In section four, we describe our empirical findings for Latin America. Finally, the last section is dedicated to some concluding remarks.

GROWTH, TRADE AND EXTERNAL RESTRICTIONS

The present section briefly reviews some theoretical findings on growth, trade and external restrictions, where the idea is to present the most important features of the neoclassical and Kaldor's growth models and see how they contribute to understand the relationship between growth and trade in the presence of external constraints.

The more mainstream analysis of growth is generally associated to the neoclassical growth model. The neoclassical model argues that economic growth is a function of the growth of factor inputs, generally set within a growth accounting framework in which a Cobb-Douglas, constant returns production function is assumed, so that if capital and labor both grow at a certain rate, and there is no technical change, then output will grow at the same rate. If markets are functioning properly, all of these resources will be allocated efficiently to the best uses; resources will be allocated to the production of goods that consumers most desire and firms will use the inputs in the most efficient manner possible to create the highest value of output.[1]

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[1] Romer (1986, 1994) can be considered an important contribution in terms of incorporating technology change as well as increasing returns in an endogenous economic growth models.

Once those conditions are considered, the actual rate of growth will converge to the potential rate of growth, which depends on the rate of growth of inputs and technical change. Regarding the neoclassical model and the role attributed to international trade, we can say that it considers that resources are used most efficiently to create the highest world value of output; and countries produce according to their comparative advantage. The current account equilibrium will be maintained and countries will export enough to pay for the imports since it is assumed that the exchange rate will adjust to equalize the supply and demand for imports and exports.

On the other hand, Kaldor's growth model argued that there were increasing returns to the manufacturing sector because new investments brings new technology, and because of learning by doing and external economies.[2] This line of argument implies that there are not diminishing returns to capital or investment, which is in clear confrontation with the neoclassical model. Economic growth models based on the developments of Kaldor's model, argue that overall growth, however, is constrained by the external balance, because if imports grow faster than exports, then a trade imbalance will develop; since a country cannot run a constant trade deficit, eventually, equilibrium in the external balance must be restored.[3] Kaldor has also pointed out as a stylized fact that there is a positive correlation between the volume of international trade and economic growth, but this is still an open question.

The model developed by Kaldor (1970) is an export-led growth model since it considers the exports as the main component of the aggregate demand, and it highlights the role of the growth rate of external demand in the domestic growth. In this model, higher rates of growth results in higher productivity growth rates and lower production costs, which favors

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[2] The so called cumulative causation express the idea where in order for the economy to grow fast, manufacturing has to grow fast; which depends on a faster growth rate of exports that relies ultimately on a competitive manufacturing sector which has to grow fast.

[3] In the neoclassical model, equilibrium is restored or maintained by flexible exchange rates. The empirical work developed here and based on Thirwall's model, there is no role for real exchange rate changes since the model considers no terms of trade effect.

exports. This kind of export-led model is in sharp conflict with the neoclassical growth strategy (outward-oriented). This model can be considered a particular case among the gap models since one of the growth restrictions is an external one and given by the restrictions to the balance of payments performance. Thirwall (1979) developed his model based on Kaldor's model and it is a growth model with balance of payments restrictions and it is a demand-led growth model. In contrast with the neoclassical models, Post-Keynesian (Kaldor) and structuralist models not only emphasize the role of effective demand and the balance of payments but also have shown how important are demand policies for economic growth, where balance of payments restrictions have a negative impact on growth.[4] One example of a structuralist growth model is the one developed by Chenery e Bruno (1962), a two-gap model, where the external gap and savings scarcity are crucial to understand long-run growth limitations.[5]

Kaldor's growth model is a key one to the development of the Post-Keynesian growth model with balance of payments constraints like the one we empirically test to Latin America in our paper. We will briefly review these two models and see to what extent there are some similarities (or not) in terms of the presence of external (balance of payments) constraints to economic growth, which is the core element of Thirwall's model. Other than this, the review of the literature deals with the export-led growth models where a faster growth of exports is crucial to improve economic growth, which can be somehow related to Thirwall's argument in favor of a low income elasticity of imports to achieve faster economic growth rates in the presence of balance of payments constraints. We also review some of the empirical results from the new trade theory with respect to the issue of opening to trade and economic performance.

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[4] Post-Keynesian growth models are associated to the export led growth and the balance of payments restrictions models. In general, they emphasize the role of investments (multiplier) and the external demand to achieve higher growth rates. On the other hand, the structuralists emphasize the importance of the demand factors to growth (demand-pull), where the current account deficit and financial aspects of the capital account play an important role for long-run growth.

[5] See Taylor (1994) for a structuralist three-gap model.

Krugman (1989) similarly showed that countries with fast growth rates usually enjoy a high income elasticity of the demand for exports and/or a low income elasticity of the demand for imports. However, Krugman questioned the direction of causation. In other words, does the ratio of the income elasticities determine the ratio of the income growth rates or are the income elasticities endogenous, being determined by the ratio of the growth rates and the fact that trade will be roughly balanced. Krugman holds the latter to be the case and formulates a simplified alternative neoclassical theoretical model to explain the relationship, with economies of scale and monopolistic competition.

Krugman refutes the first relation, arguing that differences in growth rates among countries are primarily linked to growth rates of productivity, which would explain an expansion of the world market share. The argument lacks analytical consistency: “I will simply discard a priori the argument that income-elasticity determines the growth rates, instead of the opposite. It just seems fundamentally implausible that over stretches of decades, balance of payments problems could be preventing long run growth [...]. Furthermore we all know that the differences in growth rates among the countries are primarily determined in the rate of growth of total factor productivity, not differences in the rate of the growth of employment; it is hard to see what channel links balance of payments due to unfavorable income elasticities to total factor productivity growth” (Krugman, 1989, p. 47).

In the alternative theoretical model, causality is inversed by assuming that larger varieties necessarily have guaranteed demand. In the long term, growth differences would rest exclusively in supply factors, with income elasticity adjusting and balancing the external sector of the economies, while the long-run real exchange rate remains stable.

On the other hand, according to McCombie & Thirlwall (1994, p. 389), there are a priori reasons to expect at least a certain degree of exogeneity of the income elasticity, instead of full endogeneity for the growth process. The argument runs as follows: “One should not forget that, in many cases, income elasticity of the countries are thoroughly certain for endowments of natural resources and for characteristics of the produced goods (for instance, if are ‘needs’ or luxury goods) that are products of the history and independent of the growth." Furthermore, Thirlwall (1997, p. 379), analyzing Krugman's contribution on this subject argues that "Krugman rediscovered my 'law' and called it the 45-degree rule —that is, that ratios of country growth rates appear equiproportional to ratios of income elasticities of demand for exports and imports, but he reversed the direction of causation". "In my reply to Krugman (Thirlwall, 1991, p. 379), I remind him of the many channel linking slow growth imposed by a balance-of-payments constraint to slow productivity growth [...]"[6]

A KEYNESIAN APPROACH TO ECONOMIC GROWTH

In a seminal paper, Thirlwall (1979) developed a model where the long-run growth of income is constrained by balance-of-payments. Since then, many papers have tested the simple rule derived from this Keynesian model.[7]

The model may be described as follows. The balance-of payments equilibrium condition is given by:

$$P_d X = P_f M \qquad [1]$$

where P_d and P_f are export and import prices, both expressed in domestic currency, and M and X are the quantities of imports and exports, respectively. Thirlwall uses two standard import and export demand functions:

$$M = (P_f / P_d)^g Y^h \qquad [2]$$

$$X = (P_d / P_f)^v Y^{*w} \qquad [3]$$

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[6] Additionally, there is an extensive literature, emphasizing the fact that the rate of increase in productivity is also dependent on the growth rate (the Verdoorn Law —see McCombie *et al.*, 2002).

[7] See, for example, McCombie and Thirlwall (1994) and the mini-symposium in the *Journal of Post Keynesian Economics* (1997).

where Y and Y^* are domestic and foreign income, g and v are the price elasticities for imports and exports, and h and w are the income elasticities of demand for imports and exports, respectively.[8]

Taking natural logarithms and differentiating equations [2] and [3] with respect to time, the growth rates of imports and exports can be expressed as:

$$m = g(p_f - p_d) + hy \qquad [4]$$

$$x = v(p_d - p_f) + wy^* \qquad [5]$$

where lower-case letters indicate the rate of growth of each variable.

From the equation [1] we have:

$$p_d + x = p_f + m \qquad [6]$$

Substituting equations [4] and [5] into equation [6] gives the balance-of-payments equilibrium growth rate (y_b) as:

$$y_b = [(1 + v + g)(p_d - p_f) + wy^*] / h \qquad [7]$$

Thirlwall (1979) and McCombie & Thirlwall (1994) argue that there is considerable evidence that the rate of change of relative prices has little effect on the growth of imports and exports. This could be because of low price elasticities of demand so that the Marshall-Lerner condition is only barely satisfied, or that there is real wage resistance. In this case, we have the condition that $(1 + v + g)(p_d - p_f) = 0$.

Consequently, equation [7] can be expressed as:

$$y_b = wy^* / h \qquad [8]$$

From equation [5], equation [8] can be expressed as:[9]

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[8] We are assuming that g and v are negative, while h and w are positive.

[9] An interesting comment highlighted by McCombie about the equation [9] is that it is not an identity, but it is really a behavioral function. For this subject see McCombie (1997, p. 348).

$$y_b = x / h \qquad [9]$$

This equation is known as "Thirlwall's Law" (or "Thirlwall's Simple Rule"), and implies that the balance-of-payments equilibrium growth rate depends on the long-run growth rates of real exports and the income elasticity of demand for real imports. Regarding equation [9], McCombie (1993, p. 475) emphasizes "that international differences in growth rates are fundamentally due to disparities among countries in the values of the world income elasticity of demand for their exports and their domestic income elasticity of the demand for imports (*w* and *h*, respectively)." Equation [9] also suggests "the dynamic Harrod foreign trade multiplier relation is determined by the dynamic foreign trade multiplier (1/*h*) and the growth of exports" (Atesoglu, 1993, p. 509).

In an interesting reflection on the discovery of the law in 1979, Thirlwall (1997) notes that his result is a prediction, which can be derived from the dynamic Harrod trade multiplier (Harrod, 1933), a fact that he did not realize at the time. In terms of the assumptions of the model, he conceded that they may be unrealistic in the short run, but the model is designed to understand long-run differences in growth performance. In the short run, countries can and do run balance-of-payments deficits financed by capital inflows, but they cannot finance ever-increasing inflows. Thus over the long run, the growth of the capital flows is negligible. Likewise, the terms of trade, or real exchange rate, may fluctuate in the short term, but in the long run it appears that they remain relatively stable. (Thirlwall, 1997, p. 380).[10]

A Brief Review of Empirical Results from the Literature

Thirlwall's Law can be tested by the estimation of equation [9], which will provide an estimate of the income elasticity of demand for imports,

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[10] An interesting discussion regarding long-run properties of the real exchange rate and a review of the literature on testing long-run real exchange rates can be found in Froot and Rogoff (1995). The mainstream literature has found mixed evidence supporting the existence of a constant long-run real exchange rate as we can see in

allowing us to compare the estimated growth rate with the actual long-term growth rate of real output. Most studies in the literature of balance-of-payments constrained growth models use traditional econometric techniques to estimate the income elasticity of demand for imports. Some studies have abandoned price elasticities of demand for imports and exports, following the assumptions of the "Simple Rule" (Atesoglu, 1993 and 1997). In this case, it is observed that the results of regressing y_b on y, give a slope coefficient that is not significantly different from one, in accordance with the prediction of the theory. There are others methods to test the Law. Holland *et al.* (1998) estimate the trade balance equation with income elasticities and the ratio of income elasticities as exogenous variables. In this case, the results are closely comparable with Krugman's framework, and they use tests for causality and cointegration analysis as well. It should be mentioned that estimating models based on error-correction mechanisms in order to incorporate long run trajectories are relevant, since the specification used in Thirlwall's model relies on long-run growth rates.[11]

We know that most time series are not stationary, and it has been argued that although the use of first differences often obviates the problem of nonstationary residuals, if the regressions are not cointegrated, long-

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the empirical literature (Balassa-Samuelson versus Purchasing Power Parity). For further details, see Vieira (2001).

[11] The alternative empirical literature following a different approach to discuss trade and growth was developed among others by Sachs e Warner (1995), Edwards (1998), Srinivasanand Bhagwaqti (1999), Krueger (1997) and Ben-David e Kimhi (2000) where the main common empirical result is that more opened economies converge faster to a steady-state equilibrium growth when compared to economies with high restrictions to trade. Sachs e Warner (1995) created an index for the degree of openness and the final results suggest that countries more open to trade are able to achieve faster growth rates. One of the criticisms to this approach can be found in Rodriguez e Rodrik (1999) arguing that the results from Sachs and Warner (1995) are biased and affected by factors other than the degree of openness. Edwards (1993) is an empirical investigation into the relationship between trade policy and economic performance in Latin America, and the results suggest that open to trade has a positive impact on productivity growth, and so to economic growth.

run information is lost. It is also important to recognize the estimation problems caused by the existence of structural breaks in time series data. McCombie (1997, p. 356), for instance, notes, "if a series is nonstationary, it is non-trend reverting. If, however, there is a structural break they will revert to the new, and not the old, trend".

It is fair to say that most recent empirical evidence on the balance-of-payments-constrained growth model has been obtained by the estimation of a model using cointegration analysis and a Vector Autoregressive (VAR) specification (see for example, Hieke (1997) and López & Cruz (2000)). Unfortunately, these authors neither tested for structural breaks nor considered the importance of Gaussian errors in their estimation. López & Cruz (2000, p. 486) estimated a VAR model using variables with different integration orders, or simply included the real exchange rate in the model, suggesting a straightforward link to output growth. They argue that: "in order to analyze if and how the real exchange rate affects domestic output in the long run, we estimated a VAR with domestic output and the real exchange rate." The reason for this procedure is because, in the authors' words, "[...] in Latin America the real exchange rate has undergone important fluctuations during the period under consideration." The authors did not recognize that the macroeconomic relationship between real exchange rate and output growth is not a direct one. It also depends on the relationship between the real exchange rate, exports, imports (and trade balance), domestic and foreign output growth. In other words, whether or not an exchange rate devaluation improves the trade balance depends upon taking account if (and by how) exports increase when foreign output rises and whether the Marshall-Lerner conditions hold. (Not sure if this is what you mean.)

In general, the empirical results on the balance-of-payments constrained growth model have not been able to reject Thirwall's Law. Table 1 highlights different tests for the United States and it also suggests the role played by structural breaks. Actually, "these results demonstrate once again the importance of the distinction between long and short run in discussing the balance-of-payments equilibrium growth rate" (McCombie, 1997, p. 367). Notwithstanding this, there are differences in the results, mainly explained by the existence of a statistically significant structural

TABLE **1**
The United States Balance-of-Payments Equilibrium Growth Rates and Associated Statistics

Study	*Data*	*Method*	*Period*	$\hat{h}$	*h'*	$\lvert t \rvert$	*y*	*yb*
McCombie (1997)	Annual ln	AR(1)	1952-1973	1.78	1.49	2.59*	3.36	2.88
	Annual Δln	OLS	1952-1973	1.83	1.49	1.66	3.36	2.80
	Annual ln	AR(1)	1974-1993	2.42	2.51	0.67	2.29	2.11
	Annual Δln	OLS	1974-1993	2.26	2.51	0.20	2.29	2.34
Hieke (1997)	Quart ln	OLS	1950-1966	1.29	1.23	n.a.	3.87	3.67
	Quart ln	OLS	1967-1990	2.34	2.30	n.a.	2.54	2.50
	Quart ln	OLS	1967-1986	2.44	1.88	n.a.	2.63	2.04
Atesoglu (1995)	Annual Δln	OLS	1947-1973	1.32	1.49	0.36	3.36	3.88
	Annual Δln	OLS	1974-1992	2.40	2.51	0.21	2.29	2.39
Atesoglu (1993)	Annual Δln	OLS	1955-1990	1.74	1.75	0.04	3.02	3.03
	Annual Δln	TSLS	1955-1990	1.94	1.75	0.65	3.02	2.72
Andersen (1993)	Annual	OLS	1960-1990	2.00	1.97	n.a.	3.00	2.95
Blecker (1992)	Quart ln	OLS	1977-1990	2.68	2.02	8.56*	2.70	2.03
	Quart ln	OLS	1977-1990	2.85	2.02	7.50*	2.70	1.92
	Quart Δln	OLS	1977-1990	2.07	2.02	0.13	2.70	2.63
	Quart Δln	OLS	1977-1990	2.08	2.02	0.16	2.70	2.63

Notes: $h' = x/y$; $y_b = x/\hat{h}$. |t| is the absolute value of the t statistic that tests whether $\hat{h}$ and *h'* are statistically and significantly different.
* Denotes significance at 5%.
*Source: McCo*mbie (1997, p. 366).

shift in the income elasticity of demand verified after 1973, for the United States and most developed economies.[12]

Similar empirical results obtained for the United States over the postwar period can also be observed for the United Kingdom case, when the

[12] This is the time period where most developed countries experienced changes in the exchange rate regime, moving from fixed to floating ones.

growth rates of both countries were close to their balance-of-payments equilibrium growth rates. "The evidence suggests that Japan, on the other hand, grew more slowly than its balance-of-payments equilibrium growth rate, which is consistent with the large current account surpluses it was acquiring over much of the postwar period."(McCombie, 1997, p. 373.)

Hieke (1997) tested the Law by using cointegration techniques from time series analysis and he concluded that the income elasticity of demand for imports has not been stable throughout the post World War II period. Furthermore, his findings indicate that "owing to the change in the income elasticity of demand for imports, it is appropriate to subdivide the data series already in the late 1960s." (Hieke, 1997, p. 321.)[13]

Atesoglu (1993, p. 513) suggested that relative prices (including terms of trade or exchange rate) had played an unimportant role in the determination of balance-of-payments performance insofar as testing Thirlwall's Law by using two-stage least squares estimation is concerned. In other words, "the results also imply that it is real income that adjusts in correcting for disequilibrium in the balance of payments, rather than relative prices" (Atesoglu, 1993, p. 513). Similar results were found by Holland *et al*. (1998) testing this Law for Brazil, where income effects were predominant in the 90s, whereas price effects have played an important role in the Brazilian external adjustment during the 1980s.[14]

The results from table 2 show that in Argentina, Colombia and Mexico, the estimated elasticities of demand for imports tend to exceed the equilibrium elasticities of demand for imports. In Mexico, a growth rate of exports of 1 percent is associated with a growth rate of output of 2.2 percent. It was observed that "to maintain foreign trade equilibrium (*i.e.*, equality between the growth rates of exports and imports), the elasticity of demand for imports with respect to output $\hat{h}$ should have been 0.45. However, the actual elasticity of imports was well above that figure, namely, = 1.3." (López & Cruz, 2000, p. l485).

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[13] Similar results were found by Atesoglu (1997).

[14] It should be mentioned that during the 80s Brazil has experienced significant problems related to high inflation rates and exchange rate fluctuation.

TABLE **2**

Latin American Economies Balance-of-Payments Equilibrium Growth Rates and Associated Statistics

Countries	*W*	$\hat{h}$	*h'*
Argentina (1965-1996)	0.41	2.4	2.8
Brasil (1965-1995)	0.59	1.6	1.03
Colombia (1968-1996)	1.7	0.56	1.8
Mexico (1965-1996)	2.2	0.45	1.3

Notes: The vectors are normalized for domestic GDP (*Y* = 1); w is the elasticity of exports, $\hat{h}$ and h' are the equilibrium and estimated long-run elasticities of imports with respect to domestic income, respectively. $\hat{h}$ is the inverse of the long-run elasticity of exports with respect to output, while h' is estimated using the cointegration procedure in our var for output and imports.

Source: López & Cruz (2000, p. 485).

TABLE **3**

The Balance-of-Payments Equilibrium Growth Rates and Associated Statistic of Selected Central American countries[1]

Countries	*h*	y_{obs}	y_{est}
Costa Rica (1950-96)	1.10	4.7	5.3
El Salvador (1950-96)	1.75	3.4	1.9
Guatemala (1950-96)	1.35	3.8	3.3
Honduras (1950-96)	3.70	3.8	0.7
Nicaragua (1950-96)	2.04	2.6	2.1

Source: Moreno-Brid & Pérez (1999).

[1] *h* = income elasticity of imports; y_{obs} = annual average of the growth rate of actual GDP; and y_{est} = annual average of the estimated growth rate of GDP.

Moreno-Brid & Pérez (1999, p. 144-145) found interesting results for Central America (table 3). They are convinced that the difference between the estimated and the actual average rate of growth of GDP "do not seem significant, given that the sample covers more than forty years that include important changes in economic policy such as the opening of the domestic markets to foreign trade, the dismantling of the protectionism, and the periods of civil strike and prolonged economic instability."

EMPIRICAL FINDINGS FOR LATIN AMERICA

This section brings some econometric evidence on the balance-of-payments-constrained-growth model for ten Latin American countries, using annual data from 1950 to 2000. We show that, despite national differences in terms of production structures, they reveal a common growth constraint emanating from the balance of payments.

Based on the analysis of the time series from figures 1 to 10 (see appendix) both in levels and in first difference, one can observe that real GDP, imports and exports exhibit long-term co-movements.[15] Therefore, we develop empirical tests using a Vector Autoregressive methodology. In general, the logarithms of the time series data show erratic movements when plotted in first difference form. Argentina's economy shows growth rates of GDP that are more accentuated than the others, while Bolivia has undergone a depression. Brazil, Ecuador, Mexico, Peru and Venezuela have similar patterns in their growth rates of GDP. It is fair to say that all countries started to experience negative growth rates of GDP in the 1980´s. The plots also show that the growth rates of imports became more erratic in the beginning of the 1980's.

Table 4 suggests that there was a close association between the rate of growth of real GDP and the exports, as we can see by the experiences of Brazil, Chile and Mexico. Those countries have experienced faster growth rates of real GDP and exports when compared to the other countries. On the other hand, Uruguay and Bolivia show lower growth rates of real GDP and exports. It is important to highlight that the growth rates of imports are higher than the growth rates of exports in all the countries except Ecuador and Venezuela. We can also say that not only the growth rates are higher, but the variability of imports is higher than the variability of exports for all countries, except Mexico. This argument suggests that

[15] The notation used to describe each of our time-series is based in the following specification. *L* denotes the natural log, *D* indicates first difference of the variable in natural log, *Y* denotes real GDP, *X* exports, *M* imports, and the two last letters refers to the specific country. Example: DLYAR (first difference of real GDP in natural log for Argentina). Real GDP, exports and imports in level are mean adjusted.

TABLE **4**

Growth Rates of Real GDP, Exports and Imports for Latin AmericanCountries (1950-2000)

(Annual Average in Percentages)

Countries (Sample Size)	$\overline{\Delta y}$ [1]	$\overline{\Delta x}$	$\overline{\Delta m}$
Argentina (1969-2000)	2.12 (4.98)	9.23 (16.29)	9.79 (29.13)
Bolivia (1969-2000)	2.96 (2.94)	6.49 (18.69)	8.25 (20.86)
Brazil (1951-2000)	5.34 (3.85)	7.40 (13.16)	8.11 (20.30)
Chile (1961-2000)	3.90 (5.5)	9.04 (19.63)	8.64 (20.03)
Colombia (1969-2000)	3.94 (2.36)	9.84 (13.35)	9.17 (16.64)
Ecuador (1966-2000)	4.14 (4.99)	9.67 (19.94)	8.82 (21.22)
Mexico (1958-1999)	4.62 (3.4)	12.43 (14.47)	10.52 (11.23)
Peru (1951-2000)	3.52 (4.85)	7.17 (14.59)	7.73 (21.97)
Uruguay (1956-2000)	1.77 (3.79)	5.6 (16.43)	5.95 (20.78)
Venezuela (1958-2000)	3.29 (4.1)	5.87 (25.30)	5.27 (22.72)

Source: IMF (2001).
Standard deviations reported in the parentheses.
[1] $\overline{\Delta y}$, $\overline{\Delta x}$ and $\overline{\Delta m}$ represent annual average percentage growth rates of actual GDP, exports and imports, respectively.

TABLE **5**

Unit Root Tests for Latin America: ADF (DF) Tests

ADF (DF) t-statistics[1]

Countries/ Variables[2]	*LY*	*DLY*	*LX*	*DLX*	*LM*	*DLM*	*LR*	*DLR*
Argentina	–1.805	–4.847**	–2.191	–5.191**	–1.982	–4.697**	–2.939	–6.742**
Bolivia	–2.708	–1.575	–2.137	–5.242**	–2.785	–5.367**	–3.32	–9.248**
Brazil	–1.909	–4.495**	–2.575	–4.574**	–2.676	–5.839**	–3.074	–6.806**
Chile	0.8461	–4.639**	–4.028*	–7.007**	–2.561	–5.662**	–3.521	–9.419**
Colombia	–2.144	–3.763*	–1.587	–5.373**	–1.603	–4.295**	–2.91	–6.743**
Ecuador	–2.948*	–5.076**	–1.69	–4.521**	–1.824	–5.706**	–3.197	–2.666**
México	–0.6929	–4.84**	–2.474	–3.737**	–2.878	–5.809**	–3.317*	–6.486**
Perú	–1.753	–4.75**	–2.411	–7.085**	–2.718	–7.208**	–0.9629	–7.253**
Uruguay	–3.425	–4.408**	–2.738	–6.99**	–3.358	–5.707**	–26.385**	—
Venezuela	–3.013*	–5.633 **	–2.401	–6.776**	–1.835	–6.51**	–2.871	–8.775**

[1] * and ** indicate statistically significant at 5% and 1% respectively. ADF is the Augmented Dickey-Fuller test and the DF is the Dickey-Fuller Test for unit roots.
[2] *Y* is real GDP, *X* exports and *M* imports, *D* indicates first difference and *L* indicates natural log.

there is evidence of constraints to economic growth in this region and they are related to the external sector.

The empirical results from table 5 suggest that all series in first difference are stationary (real GDP, exports, imports and real exchange rate), except for the case of real GDP for Bolivia. Some series (in levels) are also stationary, as we can see for Chile (exports), Ecuador (real GDP), Mexico (real exchange rate), Uruguay (real exchange rate) and Venezuela (real GDP). To summarize, we can say that most of the original series are integrated of order one, *i.e.*, I(1).

In order to choose the order of each one of our systems we estimate the Vector Autoregressive for real GDP, exports and imports (all in natural log) for each country, including dummy variables when they were significant and necessary to improve our model specification in terms of obtaining better results for Gaussian errors.

Table 6 reports the results of the Schwarz (SBC) and Hannan-Quinn (H-Q) tests for system reduction. Whichever lag (order) maximizes the SBC or the H-Q for each country was considered the order of our VAR. The selected system order is one for all countries according to the Schwarz criteria, and using the H-Q test for all countries except Bolivia (two), Chile (five), Mexico (three), and Peru (two).[16]

Another important issue to be considered in our model is to test for Gaussian errors. Table 6 reports the statistics tests for all ten Latin American countries for all variables of our model (real GDP, exports and imports). Those statistics tests included testing for serial correlation (represented by the letter *a*), normality (represented by the letter *b*), ARCH test (represented by the letter *c*) and heteroscedasticity (represented by the letter *d*). The properties of a well-behaved statistical model should be congruent with Gaussian errors, meaning that the test for each variable would not be able to reject the null hypothesis for each of the four statistics tests.

[16] We have used the number of lags indicated by the Schwarz criteria, except for the case of Chile for which five lags were chosen based on the indication of the Hannan-Quinn criteria, which has provided better results for Gaussian errors.

TABLE **6**

Estimating the VAR (Y, X, M): Testing for Gaussian Errors and System Order

Countries	*Dummy Variables (DU)*[2]	*Y*	*X*	*M*	*System Order (# of lags)*[3]
Argentina					One
Bolivia		*a*[1]	*c*, *dd*		One (SBC) and Two (H-Q)
Brazil	DU83*Y*, DU74*M*, DU83*M*				One
Chile				*a*	One (SBC) and Five (H-Q)
Colombia	DU99*Y*				One
Ecuador	DU73*Y*		*dd*		One
México	DU82*Y*, DU83*Y*, DU86*Y*, DU95*Y*, DU80*X*, DU86*X*, DU80*M*, DU82*M*, DU83*M*, DU 86*M*, DU 95*M*			*d*	One (SBC) and Three (H-Q)
Perú					One (SBC) and Two (H-Q)
Uruguay		*a*		*a*	One
Venezuela	DU83*Y*, DU74*X*, DU74*M*, DU83*M*				One

[1] The table reports significance levels for four diagnostic tests: *a* = An F-statistic on one-to-seven lags for serial correlation; *b* = Doornik and Hansen (1994) chi-square test for normality; *c* = The f-form of the ARCH test; *d* = The White (1980) Heteroskedasticity test. No letters for each row (country) indicates the existence of Gaussian errors. One letter denotes significance at the 10% level, and two letters at the 5% level.

[2] *Y*, *X* and *M* denote real GDP, exports and imports; DU indicates dummy variable followed by the year and the associated equation.

[3] SBC is the Schwarz Bayesian Criteria and H-Q is the Hannan-Quinn criteria.

We have found Gaussian errors for Argentina, Brazil, Colombia, Peru and Venezuela. Bolivian time series show problems of serial correlation for real GDP, and ARCH and Heteroskedasticity for exports, whereas Ecuador (exports) and Mexico (imports) also present similar problems. In the case of Uruguay, one can find problems of serial correlation for real GDP and imports. Overall, we can say that we have obtained extremely robust results for our models in terms of well-behaved errors, which is well known to be an important result when we test for cointegration.

After estimating the VAR, the hypothesis that there are cointegrating vectors in the system of real GDP growth, exports and imports was analyzed, following Johansen (1988) and Johansen & Juselius (1990) procedures. Using the Trace Test (λ_{Trace}) to test for p (the maximum number of cointegrating relationship) we have the following expression:

$$\lambda_{Trace} = -T\sum_{i=p+1}^{n}\log(1-\hat{\lambda}_i)$$

where $\hat{\lambda}_i$ is the i-th largest eigenvalue. λ_{Trace} is the of the null of r cointegrating rank against the alternative of a p cointegrating rank. Another way to test the hypothesis of p cointegrating vectors can be based on the Maximum Eigenvalue Statistic:

$$\lambda_{Max} = -T\log(1-\hat{\lambda}_{p+1})$$

In this last test, the H_0: p cointegrating vectors is against H_1: $p + 1$ cointegrating vectors. So, the first row tests the null hypothesis H_0: $p = 0$ against H_1: $p = 1$. If this is significant, H_0 is rejected. The Trace statistics are also reported. This tests the null hypothesis of H_0: p cointegrating vectors against H_1: $> p$ cointegrating vectors. Consequently, the first row tests H_0: $p = 0$ against H_1: $p > 0$. If this is significant, H_0 is rejected, and the next row tests H_0: $p = 1$ against H_1: $p > 1$.

The evidence from table 7 suggests that it is not easy to reject the hypothesis that there is one or two cointegrating vectors, except for Argentina, Chile and Uruguay. In the case of Argentina, it is important to note that if we consider the test statistics without adjusting for the number of parameters, we reject the null hypothesis that there is no cointegrating vector. For this reason, after testing for stationarity of the vector, we included an error correction mechanism (ECM) in the equation to estimate the income elasticity of imports for Argentina. In Chile and Uruguay we use the estimation of a Simple Linear Regression because there is no cointegration among real GDP, exports and imports. In the remaining countries, we obtained cointegrating vectors (see table 7) in both trace and eigenvalue tests. Thereafter, to estimate the income elasticity of imports we obtained a well-behaved Error Correction Model. The Johansen procedure is weak when Gaussian errors are not accepted and therefore we introduced dummy variables in some var specifications.

The next step of our empirical work was to estimate the income elasticities of imports for all ten Latin American countries by running a model of the first difference of imports (in natural logs) with the first difference of real GDP growth, including or not an error correction mechanism (ECM) as well as lagged variables when necessary. According to table 8, the range of estimated income elasticities of imports ranged from 2.16 (Brazil) to 4.58 (Mexico), with the exception of Ecuador (0.42) that was not statistically significant. All the remaining estimated income elasticities of imports were statistically significant for Latin American economies.

The results reported in table 8 contain a new procedure in testing Thirwall's balance-of-payments constrained growth model in the form of equation [9], namely $y_b = x/h$. The results from the estimated model and the actual data for the average annual growth rates of real GDP, so that we can have an idea of how closely this model predicts the long-run growth paths of real income for developing countries.[17] Table 8 reports which econometric model was chosen to estimate the income elasticities of imports and, thereafter, the estimated annual growth average for real GDP according to the balance-of- payment constrained model given by equation [9].

The estimated model for Argentina, Chile, Peru and Uruguay gives us very similar results when compared to the average growth rates of the

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[17] The only work that we know that provides similar statistics is Moreno-Brid & Pérez (1999), table 3.

TABLE **7**

Cointegration Analysis: Maximum Eigenvalue and Trace Statistics

Countries	*Ho: rank = p*	λ_{MAX}	*95%*	λ_{Trace}	*95%*
Argentina	*p* = 0	9.47	21.0	18.72	29.7
	P ((1	7.77	14.1	9.25	15.4
	P < = 2	1.48	3.8	1.48	3.8
Bolivia	*p* = 0	28.86**	22.0	52.93**	34.9
	P < = 1	19.03*	15.7	24.07*	20.0
	P < = 2	5.04	9.2	5.04	9.2
Brazil	*p* = 0	29.05**	21.0	46.32**	29.7
	P < = 1	16.18*	14.1	17.27*	15.4
	P < = 2	1.08	3.8	1.08	3.8
Chile	*p* = 0	12.97	22.0	26.77	34.9
	P < = 1	11.47	15.7	13.8	20.0
	P < = 2	2.33	9.2	2.33	9.2
Colombia	*p* = 0	72.02**	22.0	88.47**	34.9
	P < = 1	12.21	15.7	16.45	20.0
	P < = 2	4.245	9.2	4.24	9.2
Ecuador	*p* = 0	41.31**	22.0	64.95**	34.9
	P < = 1	16.82*	15.7	23.64**	20.0
	P < = 2	6.829	9.2	6.829	9.2
México	*p* = 0	38.99**	21.0	49.20*	29.7
	P < = 1	9.0	14.1	10.21	15.4
	P < = 2	1.21	3.8	1.21	3.8
Peru	*p* = 0	23.34*	22.0	38.66*	34.9
	P < = 1	11.93	15.7	15.32	20.0
	P < = 2	3.391	9.2	3.391	9.2
Uruguay	*p* = 0	10.5	21.0	12.68	29.7
	P < = 1	2.02	14.1	2.174	15.4
	P < = 2	0.15	3.8	0.15	3.8
Venezuela	*p* = 0	17.1	21.0	32.87*	29.7
	P < = 1	14.62*	14.1	15.77*	15.4
	P < = 2	1.152	3.8	1.152	3.6

* and ** indicate statistically significant at 5% and 1% respectively.

real GDP from actual data. For the remaining cases, we can say that there are some discrepancies around 1 percentage point and 1.5 percentage points from the actual mean to the mean of the estimated model, figures that do not look like very large once we consider that we are estimating a

TABLE **8**
Actual and Estimated Average Annual Growth Rates of Real GDP
for Latin America (%) and Income Elasticities for Imports

Country (Sample Size)	$\bar{y}$ *(%)*[1]	$\hat{y}$ *(%)*[2]	*h*[3]	*Model*[4]
Argentina (1969-2000)	2.12 (4.98)	2.26 (4.13)	4.0776 [7.895]	ECM [–3 829] AR(1) [4 156]
Bolivia (1969-2000)	2.96 (2.94)	1.42 (4.08)	4.5725 [5.349]	ECM [–6 215]
Brazil (1951-2000)	5.34 (3.85)	3.42 (6.08)	2.1642 [2.785]	ECM [–2 876] AR(1) [1 975]
Chile (1961-2000)	3.9 (5.5)	3.33 (7.23)	2.7163 [8.203]	SLR DU74
Colombia (1969-2000)	3.94 (2.36)	2.26 (3.06)	4.3557 [4.426]	ECM [–2 076]
Ecuador (1966-2000)	4.14 (4.99)	2.52 (6.43)	0.42947 [0.543]	AR(1)[–2 442]
Mexico (1958-1999)	4.62 (3.4)	2.72 (3.16)	4.5824 [11.223]	ECM [–8 013] DU74, DU80, DU82, DU83, DU88
Peru (1951-2000)	3.52 (4.85)	2.84 (5.77)	2.5309 [4.927]	ECM [–2 812]
Uruguay (1956-2000)	1.77 (3.79)	1.61 (4.72)	3.4848 [5.405]	SLR
Venezuela (1958-2000)	3.29 (4.1)	1.54 (6.59)	3.8354 [6.146]	ECM [–2 448]

[1] $\bar{y}$ = Average growth rate for actual GDP and standard deviation in parenthesis (%).
[2] $\hat{y}$ = Average growth rate for estimated GDP and standard seviation in parenthesis (%).
[3] t-values for income elasticities of imports are presented in brackets.
[4] MCE = Error Correction Model, AR(1) = First order Autoregressive component and SLR = Simple Linear Regression. *t*-value are presented in brackets.

long-run model based only in three variables (real GDP, exports and imports). And we know that long-run growth of real GDP will also depend on some other variables that are not included in our model. In fact, those estimations focused on the demand side of the Latin American economies. Price considerations were not taken into account, so that we could test equation [9] presented in the first part of this paper. We acknowledge that this is a slightly restrictive assumption, mainly because in many countries real exchange rates are not stationary in level (table 5). It is important to highlight that our estimation did not take into account capital flows. We can argue that due to those two central constraints, there are discrepancies between the actual and the estimated real GDP growth.

On the other hand, if we compare our results with the ones from the literature for developed countries (see table 1), we can argue that Brazil and Chile were the most similar to them among Latin American countries, where the other countries presented high income elasticities.

Concluding Remarks

The present paper used a VAR specification to investigate the empirical validity of the balance-of-payments-constrained-growth model for ten Latin American countries during the period of 1950-2000. The focus of the empirical evidence was the income side as proposed by the original Thirlwall´s rule, but we are aware that it is very important to take into account variables such as the exchange rate and the terms of trade, something to be done in future research. In the 1990s, Latin America experienced an intensive capital inflow, a fact to be considered as an important issue when testing Thirlwall´s model.

We found strong evidence of a long-run association among real GDP, exports and imports mainly for the cases of Brazil and Chile. Moreover, our results indicated that the countries with the fastest long-term growth rates of real GDP are compatible with the balance-of-payments equilibrium condition expressed by low income elasticity of imports, except Mexico. The empirical results for Mexico indicated the presence of a high income elasticity when compared to the other countries, but also of high rates of growth of real GDP. On the other hand, and according to Thirlwall´s rule, we have Uruguay, Argentina and Bolivia with low income elasticities of imports and low real GDP growth rates.

It is fair to say that our empirical analysis has provided some important insights that can be used as a benchmark for future research on long-term growth policies for developing countries when they face external constraints. We can argue that in order to grow under balance-of-payments equilibrium condition government policies must be guided towards overcoming external sector constraints, mainly by increasing the rate of growth of exports and reducing the income elasticity of imports.

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APPENDIX

FIGURE **1**
Argentina: Time-Series in Levels and in First Differences (1950-2000)

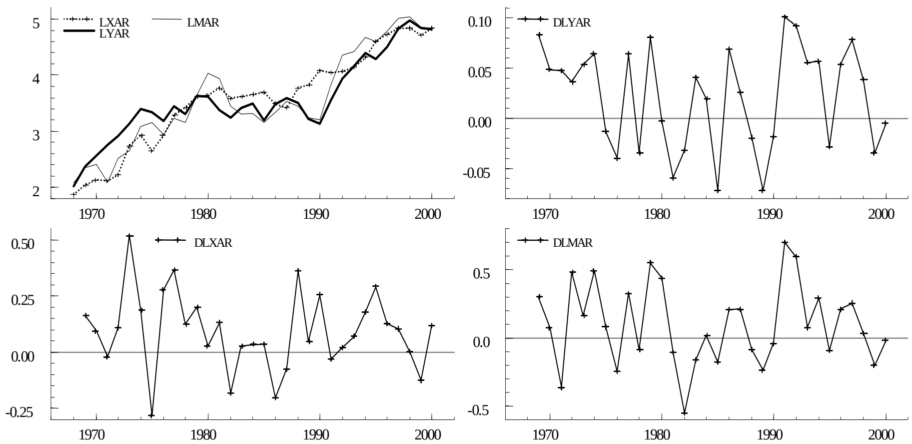

FIGURE **2**
Bolivia: Time-Series in Levels and in First Differences (1950-2000)

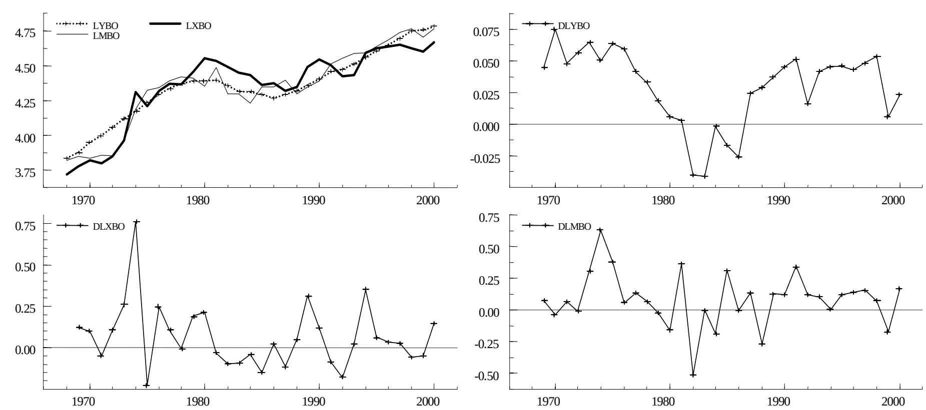

FIGURE **3**
Brazil: Time-Series in Levels and in First Differences (1950-2000)

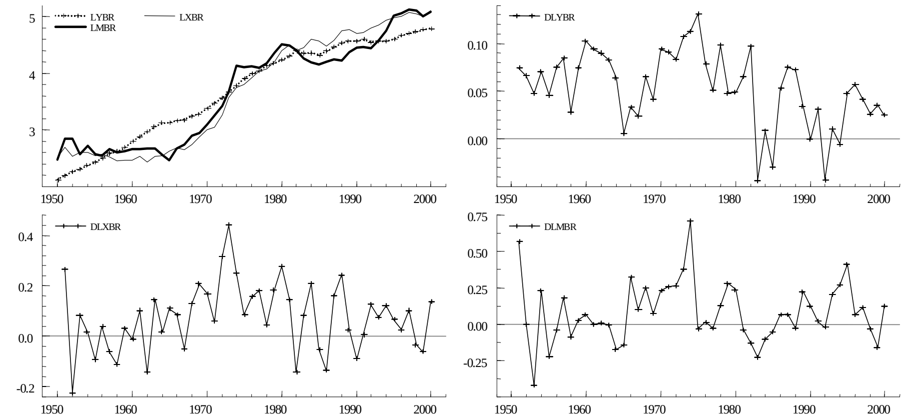

FIGURE **4**
Chile: Time-Series in Levels and in First Differences (1950-2000)

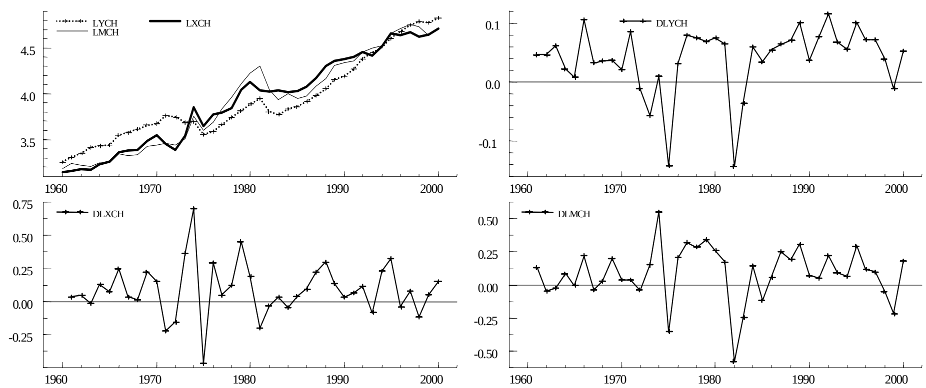

FIGURE **5**

Colombia: Time-Series in Levels and in First Differences (1950-2000)

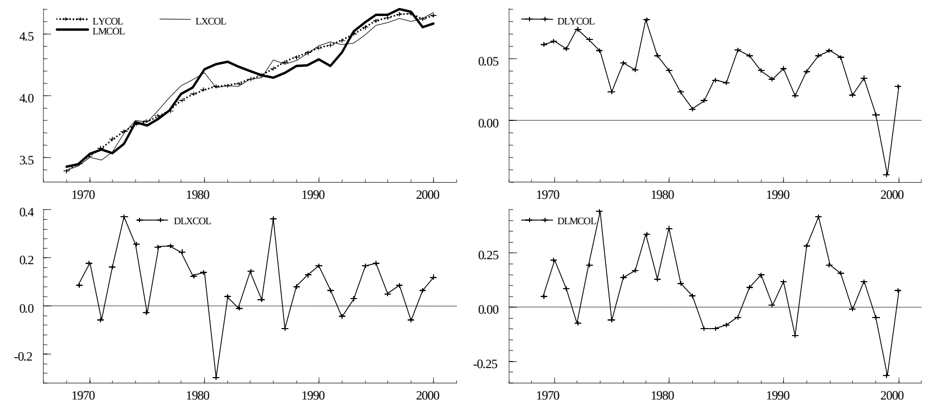

FIGURE **6**

Ecuador: Time-Series in Levels and in First Differences (1950-2000)

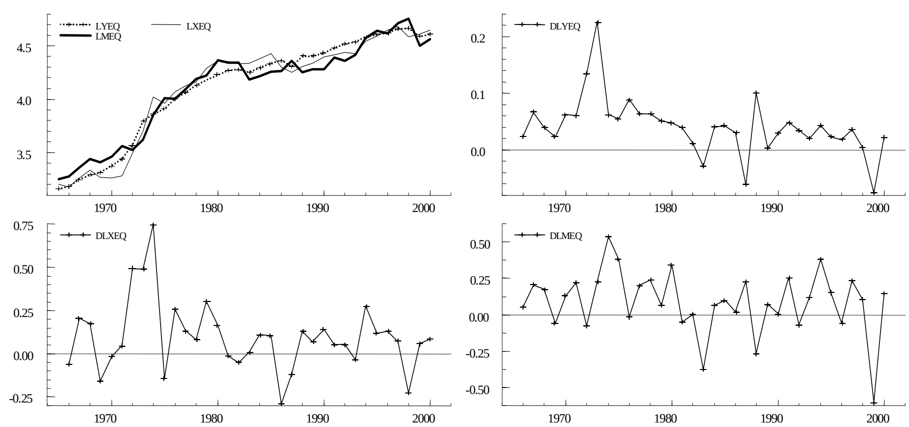

FIGURE **7**

Mexico: Time-Series in Levels and in First Differences (1950-2000)

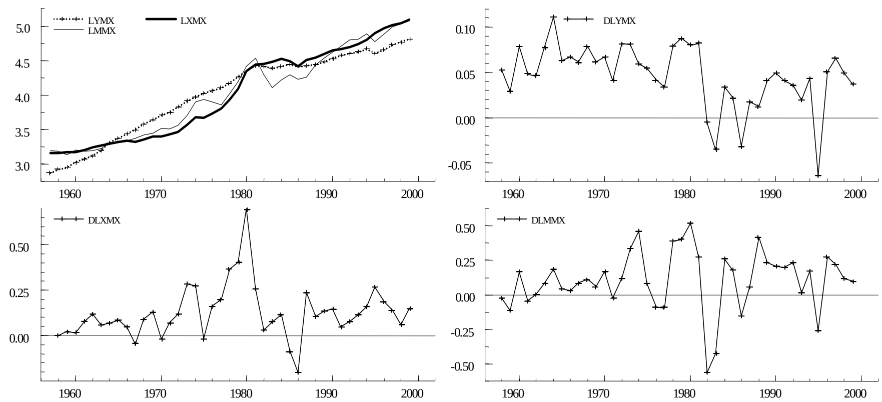

FIGURE **8**

Peru: Time-Series in Levels and in First Differences (1950-2000)

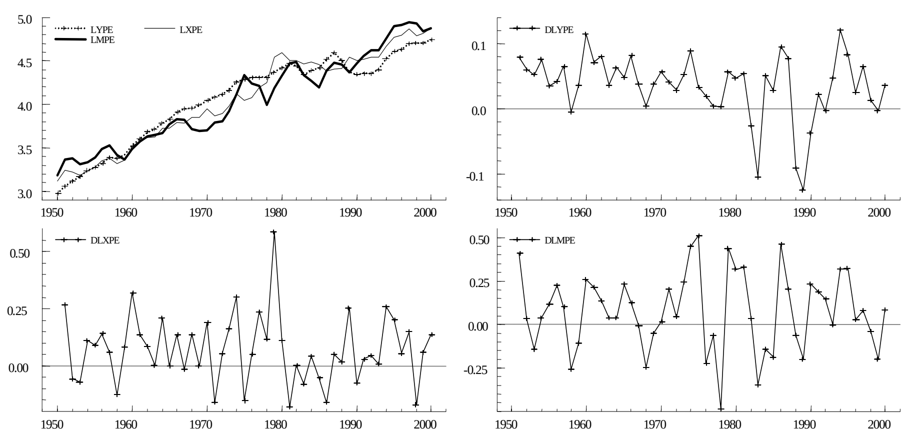

FIGURE **9**
Uruguay: Time-Series in Levels and in First Differences (1950-2000)

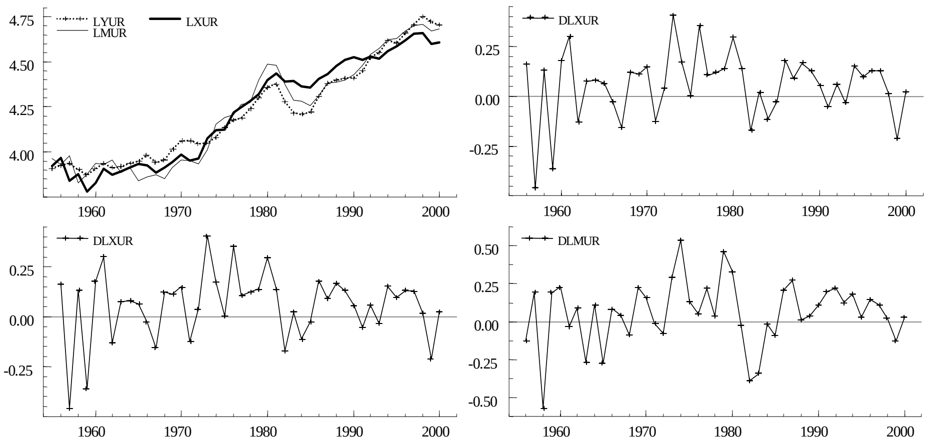

FIGURE **10**
Venezuela: Time-Series in Levels and in First Differences (1950-2000)