Economic growth and the balance-of-payments constraint in Latin America

Márcio Holland [•]
Flávio Vilela Vieira [♦]
Otaviano Canuto [♣]

Abstract: The paper presents an empirical investigation into the determinants of long-run growth for ten Latin American countries based on the balance of payments constrained growth model developed by Thirlwall (1979) and McCombie & Thirwall (1994). One of the goals is to estimate the income elasticities of imports in order to test Thirlwall´s law and see how well this model can be used to predict long-run growth in Latin America. Our approach suggests that Latin American economies should face significant changes in their specialization path if the goal would be to reach sustainable long-run growth rates, mainly increasing the growth rate of exports jointly with lowering income elasticity of the demand for imports.

Introduction

This paper examines the relationship between economic growth and 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 will be implemented for a set of Latin American economies. The main objective is to estimate the equilibrium long-run growth rates, as indicated by Thirlwall´s Law, as well as to investigate whether the estimated growth rates are close to the actual growth rates. Afterwards, we apply some econometric techniques, using cointegration analysis from a VAR specification and the estimation of income elasticities of imports.

The econometric evidence regarding the validation of Thirlwall´s Law in Latin America points out that even though there are different periods of external adjustment, it has not been possible to reject the main proposition of Thirlwall´s Law. In other words, no single economy is immune from its external sector constraints. Our approach suggests that Latin American economies should face significant changes in their specialization path if the goal would be to reach sustainable long-run growth

rates, mainly by increasing the growth rate of exports jointly with lowering income elasticity of the demand for imports.

The paper will be structured in four sections. The next section will address the balance of payments constrained (keynesian) growth model originally developed by Thirlwall (1979). Section two presents a brief review of empirical results from the literature. Section three describes our empirical findings for Latin America. Finally, the last section is dedicated to some concluding remarks.

1. A keynesian economic growth approach

In a seminal paper, Thirlwall (1979) developed a long-run income growth model, in a balance-of-payments constrained situation. Since that, many papers have been written to test the simple rule derived from this keynesian model. Starting from the balance-of payments equilibrium condition:

(1) $P_d X = P_f M$

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:

(2) $M = (P_f / P_d)^g Y^h$

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

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.

Using natural logarithms and differentiating equations (2) and (3), the growth rates of imports and exports can be expressed as:

(4) $m = g(p_f - p_d) + hy$

(5) $x = v(p_d - p_f) + wy^*$

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

From the equation (1) we have that:

(6) $p_d + x = p_f + m$

Substituting equations (4) and (5) into equation (6) gives the equilibrium growth rate (y_b):

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

Thirlwall (1979) and McCombie & Thirlwall (1994) assume that the real terms of trade (or the real exchange rate) ramains constant in the long run. Therefore, considering this assumption we have that:

$p_d - p_f = 0$

Then, equation (7) can be expressed as:

(8) $y_b = wy^*/h$

Based on equation (5), we can rewrite equation (8) in the following way:

(9) $y_b = x/h$

This equation has been known as “Thirlwall’s Law” (or “Simple Rule”), implying that the balance-of-payments equilibrium growth rate depends on long-run growth rates of real exports and the income elasticity of demand for real imports. Regarding equation (9), McCombie (1993) 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).”(p.475). Equation (9) also suggests that “the dynamic Harrod foreign trade multiplier relation is determined by the dynamic foreign trade multiplier (1/*h*) and the growth of exports” (Atesoglu, 1993: 509).

In an interesting reflection, Thirlwall (1997) argues that his result is a prediction which can be extracted from the dynamic Harrod trade multiplier (Harrod, 1933), something that was not realized by himself at the time. In terms of the

assumptions of the model, he assumed that they may appear unrealistic in the short run, but the model is designed to understand long run differences in growth performance. In the short run, countries can run payments deficits financed by capital inflows, but they cannot finance ever-increasing inflows. 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. (p. 380). Similar comments may be valuable for the further assumption that the growth of the capital flows is negligible.

The data examined by Krugman (1989) shows that countries with fast growth rates usually enjoy a high income elasticity of the demand for exports (wy^*) and/or a low income elasticity of the demand for imports (h). The author used a simplified econometric model for the empiric appreciation of this hypothesis, starting from a linear regression model:

(10) $\ln(w/h) = \propto_0 + \propto_1 \ln(y/y^*)$

where y and y^* are respectively the growth rates of country and of the rest of the world.

The relationship (10) is obtained from the dynamic "multiplier of trade of Harrod" (McCombie & Thirlwall, 1994: 388). Based on the argument stated before regarding equation (10), we have the following equation:

(11) $(y/y^*) = (w/h)$

Given a situation of stability in the real exchange rate and the economy working below full capacity, the ratio of domestic and foreign growth rates is equal to the ratio of the income elasticity of demand for exports and the income elasticity of demand for imports.

However, Krugman questioned the existence of a more appropriate causality relationship. In other words, whether the ratio of the income elasticities determines the ratio of the growth of the income or the differentiated growth rates cause the trade balance. The author formulates a simplified alternative theoretical model, with economies of scales and monopolistic competition, where the causality would be reverted.

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. His 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: 47).

In the alternative theoretical model, the reversion of the causality assumes 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 external sector of the economies, with long-run real exchange rate remaining stable.

On the other hand, according to McCombie & Thirlwall (1994: 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. For instance: "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), 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” (p. 379). “In my reply to Krugman (Thirlwall, 1991), I remind him of the many channel linking slow growth imposed by a balance-of-payments constraint to slow productivity growth (...)” (p. 379).

Additionally, there is an extensive literature, emphasizing the possibilities that the increase in productivity is also dependent of the growth rate (Verdoorn Law). If

balance-of-payments-constrained models impose limits to demand expansion for the domestic economy, the connection channels are contested by Krugman.

2. 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 estimation of income elasticity of demand for imports, allowing us to compare the estimated growth rate with the actual long term growth rate of real output. Most surveys in the literature of balance-of-payments constrained growth models use traditional econometric techniques to estimate the income elasticity of demand for imports. On the other hand, some studies have abandoned price elasticties of demand for imports and of supply of 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, especially if the slope coefficient is not significantly different from one. There are others methods to test the Law. Holland et alli (1998) estimate equation (11) and a trade balance equation with income elasticities and the ratio of income elasticities as exogenous variables. In this case, results are closely comparable with Krugman's framework, estimating causality and cointegration analysis as well. It should be mentioned the relevance of estimating models based on error-correction mechanisms in order to incorporate long run trajectories, since the specification used in Thirlwall's model relies on long-run growth rates.

We know that most time series are not stationary, and it has been argued that although the use of first differences obviates the problem of nonstationary residuals, long-run information is lost. It is absolutely important to highlight estimation problems caused by the existence of structural breaks in times series. McCombie, for instance, is worried with the fact that "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" (p. 356).

It is fair to say that most empirical evidence on the balance-of-payments-constrained growth model has been obtained by the estimation of a model using cointegration analysis and a VAR's (Vector Autoregressive) specification, as we can see in Hieke (1997) and López & Cruz (2000). Unfortunately, these authors did not

test for structural breaks neither considered the importance of Gaussian errors in their estimation. The authors estimated a VAR model using variables with different integration orders (p. 484), or simply including 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" (p. 486). 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" (p. 486). The authors did not observe that the macroeconomic interdependence channel 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, if and how much the exports improve when the foreign output improves, or if the Marshall-Lerner condition is fulfilled in terms of testing when an exchange rate devaluation improves the trade balance.

In general, the empirical results on the balance-of-payments constrained growth model have not been able to reject the 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, 1997:367). Notwithstanding, there are differences in the results, mainly explained due to the existence of a statistically significant structural shift in the income elasticity of demand verified after 1973, for the United States and most developed economies.

Table 1. The United States balance-of-payments equilibrium growth rates and associated statistics

Study	**Data**	**Method**	**Period**	$\hat{h}$	h'	|t|	y	y_b
McCombie (1997)	Annual ln	AR(1)	1952-73	1.78	1.49	2.59*	3.36	2.88
	Annual Δln	OLS	1952-73	1.83	1.49	1.66	3.36	2.80
	Annual ln	AR(1)	1974-93	2.42	2.51	0.67	2.29	2.11
	Annual Δln	OLS	1974-93	2.26	2.51	0.20	2.29	2.34
Hieke (1997)	Quart ln	OLS	1950-66	1.29	1.23	n.a.	3.87	3.67
	Quart ln	OLS	1967-90	2.34	2.30	n.a.	2.54	2.50
	Quart ln	OLS	1967-86	2.44	1.88	n.a.	2.63	2.04
Atesoglu (1995)	Annual Δln	OLS	1947-73	1.32	1.49	0.36	3.36	3.88
	Annual Δln	OLS	1974-92	2.40	2.51	0.21	2.29	2.39
Atesoglu (1993)	Annual Δln	OLS	1955-90	1.74	1.75	0.04	3.02	3.03
	Annual Δln	TSLS	1955-90	1.94	1.75	0.65	3.02	2.72

Andersen (1993)	Annual ECM	OLS	1960-90	2.00	1.97	n.a.	3.00	2.95
Blecker (1992)	Quart ln	OLS	1977-90	2.68	2.02	8.56*	2.70	2.03
	Quart ln	OLS	1977-90	2.85	2.02	7.50*	2.70	1.92
	Quart Δln	OLS	1977-90	2.07	2.02	0.13	2.70	2.63
	Quart Δln	OLS	1977-90	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 that case this is the case at the 95% confidence level.
Source: McCombie (1997:366).

Empirical results obtained for the United States over the postwar period can also be observed for the United Kingdom case, when the growth rates 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: 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: 321).

Atesoglu (1993: 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. 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: 513). Similar results were obtained by Holland et alli (1998), when testing this Law for Brazil: income effects were predominant in the 90s, whereas price effects had played an important role in the Brazilian external adjustment during the 80s.

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. “Thus, 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: 485).

Table 2. Latin American Economies balance-of-payments equilibrium growth rates and associated statistics.

Countries	w	$\hat{h}$	h'
Argentina (1965-96)	0.41	2.4	2.8
Brazil (1965-95)	0.59	1.6	1.03
Colombia (1968-96)	1.7	0.56	1.8
Mexico (1965-96)	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 cointegrating vector in the VAR for output and imports.
Source: López & Cruz (2000:485)

Moreno-Brid & Pérez (1999) 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 taht he 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"(p. 144-5).

Table 3. Central American Economies' balance-of-payments equilibrium growth rates and associated statistics[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.

3. 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 intend to show that, despite national differences in terms of production structures, they reveal some common growth constraint from the balance of payments.

Based on the analysis of the time series from figure 1, both in levels and in first difference, one can observe that real GDP, imports and exports present long term co-movements. Therefore, we develop empirical tests using a VAR (Vector Autoregressive) methodology. In general, they show erratic movements when plotted in first difference. Argentina´s economy presents growth rates of GDP more accentuated than the others, while Bolivia has undergone a depression. Brazil, Ecuador, Mexico, Peru and Venezuela have similar behavior in their growth rate of GDP. It is fair to say that all countries started to experience negative growth rates of GDP in the 80´s. The plots have shown us that the growth rates of imports became more erratic in the beginning of the 80´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 ones. 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 there is evidence of some constraints to economic growth in this region and they are related to the external sector.

Table 4. Growth rates of real GDP, exports and imports for Latin American Countries (1950-2000) – (annual average in percentual)

Country (Sample Size)	$\overline{\Delta y}_1$	$\overline{\Delta x}$	$\overline{\Delta m}$
Argentina (1969-2000)	2.12(4.98)[2]	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)

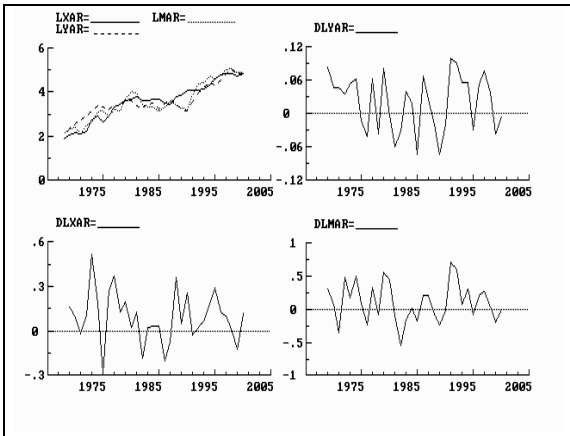
Source: IMF (2001)

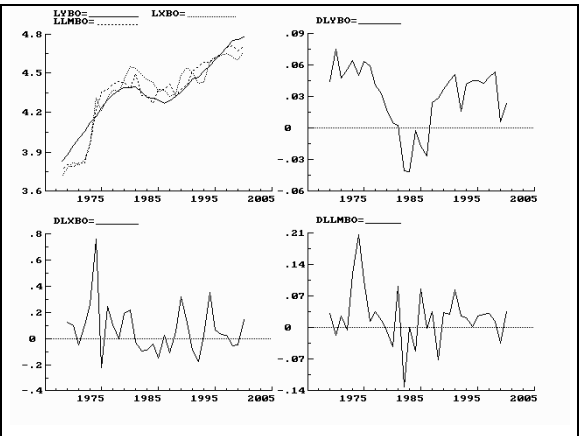
[1] $\overline{\Delta y}$, $\overline{\Delta x}$ and $\overline{\Delta m}$ represent annual average of the growth rate of actual GDP, exports and imports, respectively.
[2] Standard deviations are informed in parenthesis.

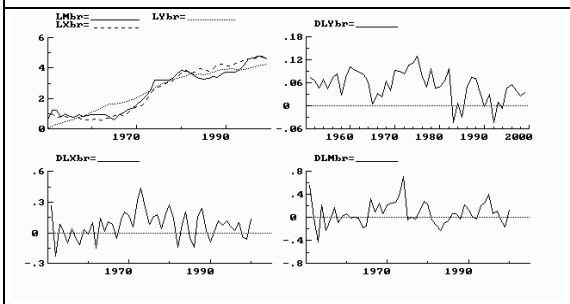
Table 5 below describes the unit root tests for ten Latin American economies using the Augmented Dickey-Fuller test (ADF). The procedure adopted in this paper was to run the ADF test for five lags for each series in natural log and the first difference to test for stationarity of the series. If the lagged first difference terms were not significant, we then looked at the time trend for significance. When both terms were not significant, we reported the test statistics for the Dickey-Fuller (DF) test.

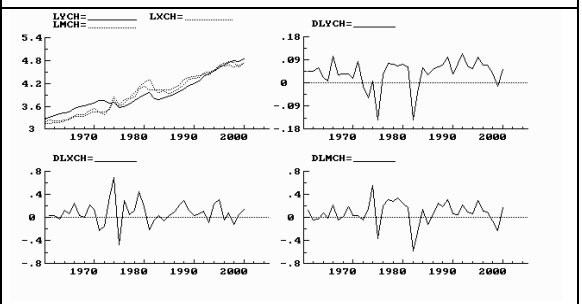
The empirical results from table 5 suggests that all series in first difference are stationary (real GDP, exports, imports and real exchange rate), except for the case of real GDP for Bolivia. Some series (in levels) are also stationary, as we can see for Chile (exports), Ecuador (real GDP), Mexico (real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

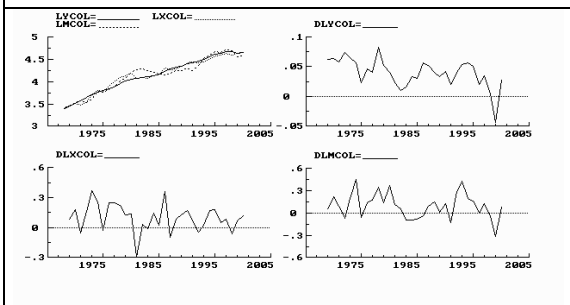
Figure 1. Latin America: Time-Series in levels and in first differences (1950-2000)

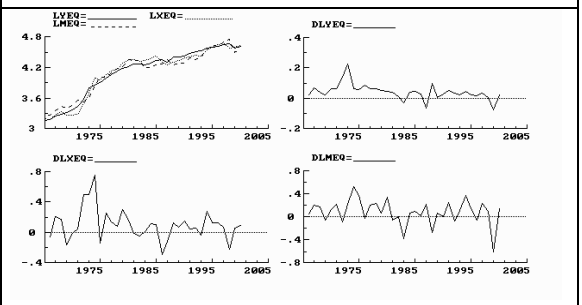

LXAR=
LMAR=
LYAR=
DLYAR=
DLXAR=
DLMAR=

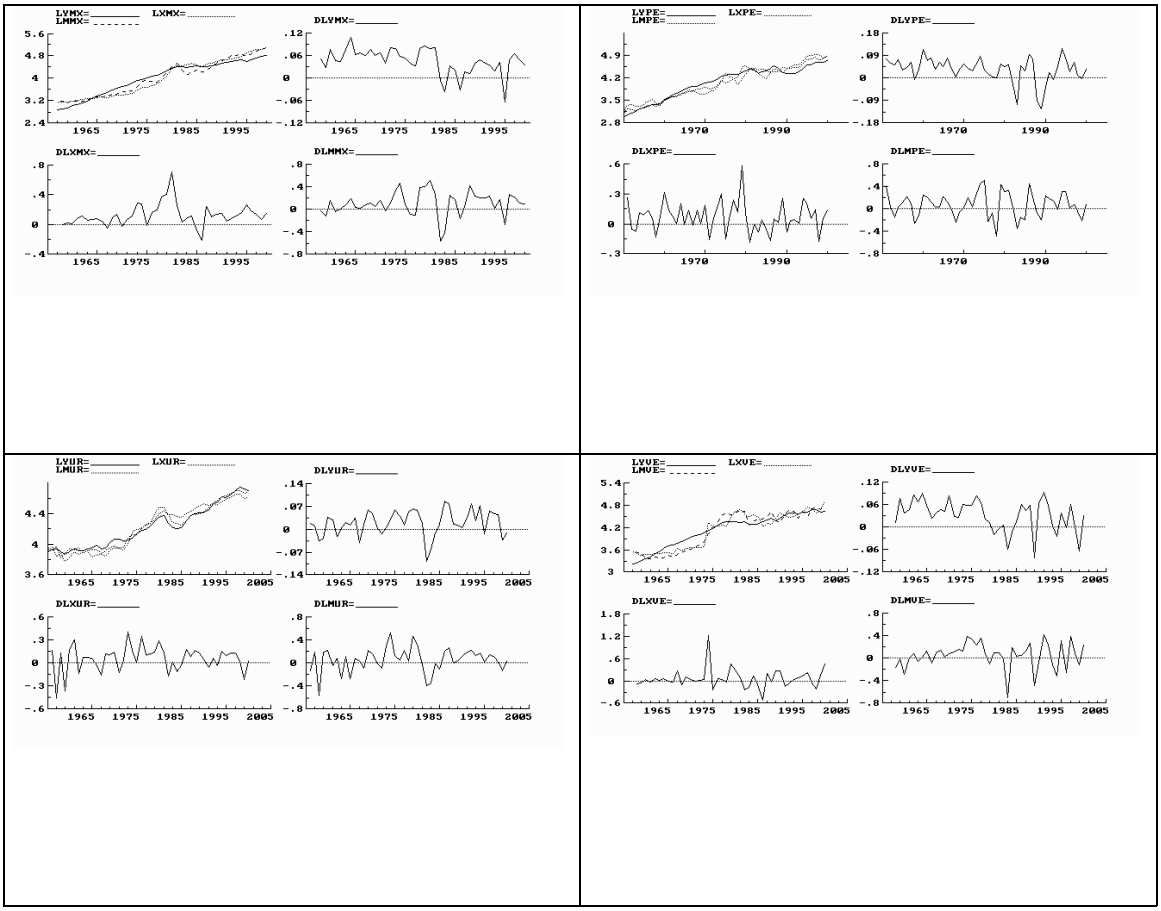

LYBO=
LLMBO=
LXBO=
DLYBO=
DLXBO=
DLLMBO=


LMbr=
LXbr=
LYbr=
DLYbr=
DLXbr=
DLMbr=


LYCH=
LMCH=
LXCH=
DLYCH=
DLXCH=
DLMCH=


LYCOL=
LMCOL=
LXCOL=
DLYCOL=
DLXCOL=
DLMCOL=


LYEQ=
LMEQ=
LXEQ=
DLYEQ=
DLXEQ=
DLMEQ=



Source: IMF (2001)

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 **
Mexico	- 0.6929	- 4.84 **	- 2.474	- 3.737 **	- 2.878	- 5.809 **	- 3.317 *	- 6.486 **
Peru	- 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.

In order to choose the order of each one of our systems we estimate the Vector Auto-Regressive (VAR) for real GDP, exports and imports (all in natural log) for

each country, including or not 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).

Another important issue to be considered in our model is to test for Gaussian errors. Table 6 contains 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.

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	DU83Y, DU74M, DU83M				One
Chile				**a**	One (SBC) and Five (H-Q)
Colombia	DU99Y				One
Ecuador	DU73Y		**dd**		One
Mexico	DU82Y, DU83Y, DU86Y, DU95Y, DU80X, DU86X, DU80M, DU82M, DU83M, DU86M, DU95M			**d**	One (SBC) and Three (H-Q)
Peru					One (SBC) and Two (H-Q)
Uruguay		**a**		**a**	One
Venezuela	DU83Y, DU74X, DU74M, DU83M				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.
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. After all, 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) e 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 against H_1: p+1 cointegrating vectors. So, the first row test H_0: p = 0 against H_1: p = 1. If this is significant H_0 is rejected. Trace statistics are also reported. This tests H_0: p cointegrating vectors against H_1: > p cointegrating vectors. So 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 Uruguai. 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 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.

Table 7: Cointegration Analysis: Maximum Eigenvalue and Trace Statistics

Countries	Ho: rank = p	λ_{MAX} [1]	95%	λ_{Trace}[1]	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
Mexico	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

[1] Adjusted for the number of parameters.

The results from table 8 can be considered a novelty element to the literature testing Thirwall´s Balance of Payments Constrained Growth Model since they report 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 does this model can be used to predict long-run growth paths of real income for developing countries. Table 6 reports which econometric technique was used to estimate income elaticities of imports and, thereafter, the estimated annual growth average for real GDP according to the balance-of- payment constrained model.

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]	$\hat{\bar{y}}_{(\%)}$[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] $\hat{\bar{y}}$ = average growth rate for estimated GDP and Standard Deviation 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

The estimated model for Argentina, Chile, Peru and Uruguay gives us very similar results when compared to the average growth rates of real GDP from actual data. For the remaining cases, we can say that there are some discrepancies around 1 p.p. and 1.5 p.p. 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 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 income 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 acknowedge 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 conclude that Brazil and Chile were the most similar to them among Latin American countries. The other countries presented high income elasticities.

5. 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 90s 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.

We believe that our empirical analysis has provided some important remarks in terms of future research and about long-term growth policies for developing countries. 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.

References

Atesoglu, H. S. (1997). *Balance-of-payments-constrained growth model and its implications for the United States*. **Journal of Post Keynesian Economics**, Spring 1997, vol. 19, No. 13.

Atesoglu, H. S. (1993). *Balance-of-payments-constrained growth*. **Journal of Post Keynesian Economics**, Summer 1993, vol. 15, No. 4.

Froot, K. and K. Rogoff (1995) “Perspectives on PPP and Long-Run Real Exchange Rates.” In: G. Grossman and K. Rogoff (eds), **Handbook of International Economics**, vol. III, chapter 32, 1646-88, North-Holland, Amsterdam.

Harrod, R. (1993). **International economics**. Cambridge, Cambridge UP, 1993.

Hieke, H. (1997). *Balance-of-payments-constrained growth: a reconsideration of the evidence for the U. S. economy*. **Journal of Post Keynesian Economics**, Spring 1997, vol. 19, No. 13.

Holland, M. et. alli (1998). *Taxa de câmbio, elasticidades-renda, saldo comercial na economia brasileira*. **Revista Brasileira de Economia**, Abril/Jun 1998.

IMF (2001). **International Financial Statistics**. May 2001. CD-Rom

Johansen, S (1988). *Statistical analysis of cointegrating vectors*. **Journal of**

Economic Dynamics and Control, 12.

Johansen, S. & Juselius, K. (1990). *Maximum likelihood estimation and inference on cointegration*. **Oxford Bulletin of Economics and Statistics**, 52.

Krugman, P. (1989). *Difference in income elasticities and trends in real exchange rates.* **European Economic Review**, May 1989.

López, J. & Cruz, A. (2000). *"Thirlwall's Law" and beyond: the Latin Amercian experience*. **Journal of Post Keynesian Economics**, Spring 2000, vol. 22, No. 3.

McCombie, J. S. L. (1997). *On the empirics of balance-of-payments-constrained growth.* **Journal of Post Keynesian Economics**, Spring 1997, vol. 19, No. 13.

McCombie, J. S. L. (1993). *Economic growth, trade intelinkages, and the balance-of-payments constraint*. **Journal of Post Keynesian Economics**, Summer 1993, vol. 15, No. 4.

McCombie, J. S. L. & Thirlwall, A. P. (1994). **Economic growth and the balance-of-payments constraint**, London, St. Matins's Press, 1994.

Moreno-Brid, J. C. & Pérez, E. (1999). Balance-of-payments-constrained growth in Central América: 1950-96. **Journal of Post Keynesian Economics**, Fall 1999, vol. 22, No.1.

Thirlwall, A. P. (1997). *Reflections on the concept of balance-of payments-contrained growth*. **Journal of Post Keynesian Economics**, Spring 1997, vol. 19, No. 13.

Thirlwall, A. P. (1991). *Professor Krugman's 45-degree rule*. **Journal of Post Keynesian Economics**, Fall 1991, Vol. 14.

Thirlwall, A. P. (1979). *The balance of payments constrained growth as an explanation of international growth rate differences*. **Banca Nazionale del Lavoro Quarterly** Review, 1979, 128.

Vieira, F. V. (2001). **A Unified Approach to Testing for Mean Reversion of Exchange Rates and Prices**: The OECD and Latin American Cases. Ph.D Dissertation, Department of Economics, University of New Hampshire.