Aggregate Demand and the Endogeneity of the Natural Rate of Growth: evidence from Latin American economies

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Abstract

This paper aims to explore the Keynesian idea that aggregate demand matters for economic activity, both in the short run and in the long run. To that extent, it discusses the endogeneity of the natural rate of growth, and presents two empirical exercises: the first one tests for unit roots in output for twelve Latin American countries using panel data. The results suggest that GDP series are non-stationary and therefore shocks (both from supply and demand) may have persistent effects in the economy. The second exercise tests the hypothesis of an endogenous natural rate of growth, and the estimations suggest that the potential output has been influenced by the actual level of economic activity in Latin American economies. This result corroborates the hypothesis that aggregate demand has long-run effects in the economy, as stated by Keynes.

Keywords: natural rate of growth, aggregate demand, Keynes.

Resumo

Este artigo busca explorar a idéia Keynesiana de que a demanda agregada é um elemento importante na dinâmica econômica, tanto no curto quanto no longo prazo. Para tanto, discute o conceito de endogeneidade da taxa natural de crescimento, e apresenta dois exercícios empíricos: no primeiro, são realizados testes de raiz unitária em séries de PIB para um painel de doze países da América Latina. Os resultados sugerem que o PIB é não-estacionário e, portanto, que choques exógenos (tanto de oferta quanto de demanda) têm efeitos persistentes na economia. O segundo exercício testa a hipótese de endogeneidade da taxa natural de crescimento, e as estimações sugerem que o produto potencial é afetado pelo nível de atividade econômica nas economias Latino-Americanas em questão. Este resultado corrobora a hipótese de que a demanda agregada tem efeitos a longo prazo na economia, tal como defendido por Keynes.

Palavras-chave: taxa natural de crescimento, demanda agregada, Keynes.

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1. Introduction

Mainstream economic theory has traditionally distinguished between the study of business cycles and growth. Economics textbooks usually include one or more chapters devoted to the determination of output and prices in the short run, and chapters that focus on long-run growth, in which business cycles have no role to play.

In the last two decades, however, a revived interest on the relation between business cycles and growth arose as a consequence of two major theoretical developments within the mainstream. The first one is the analysis of unit roots in macroeconomic time series, following the seminal contribution of Nelson and Plosser (1982). In this case, the traditional technique of decomposing output behavior into long-run trends and fluctuations around the trend was called into question, and it was recognized that shocks can have persistent effects in the economy.

The second factor that stimulated the interest in the long-run effects of business cycles was the upsurge of 'new growth' (or 'endogenous' growth) models, after Romer (1986, 1990) and Lucas (1988). According to this perspective, the short-run behavior of output can affect the long-run growth rates of the economy by affecting the firms' decisions to innovate and to engage in productivity-enhancing activities. However, it is clear that new growth theory (and its policy implications) focuses almost exclusively on supply-side issues, and does not address the role of aggregate demand in the system.

From a Keynesian perspective, on the other hand, one can summarize the relations between short-run cycles and long-run trends according to two propositions: (i) current developments of the economy affect its long-run trajectory, i.e. the economy presents path-dependence[2]; and (ii) aggregate demand (and money) matters both in the short run and in the long run.

This paper addresses the relation between growth and cycles from a Keynesian perspective. First, it discusses whether or not business cycles cast long shadows, i.e. whether shocks have persistent effects in the economy. In this case, the paper provides evidence of persistent shocks by testing for

[2] As in Jan Kregel's (1976) description of Keynes's shifting equilibrium model. See also Dutt (1997).

unit root in twelve Latin American countries using panel data techniques, which represent new developments in econometrics (see Hadri, 2000; Levin, Lin, and Chu, 2002; Im, Pesaran, and Shin, 2003).

However, unit root tests are not able to distinguish supply shocks from demand shocks, and therefore do not address the issue of the importance of demand for growth. The second question addressed in the paper identifies more specifically the influence of aggregate demand on output growth rates in the long-run. In particular, it will be argued that economic growth is influenced by demand because technological change, productivity and the supply of labor respond to aggregate demand growth. If this is the case, the potential output path is not considered a strong attractor towards which actual output would eventually converge, and the natural rate of growth is endogenous to the level of economic activity (Leon-Ledesma and Thirlwall, 2002). The paper will present empirical evidence on this issue, by testing the hypothesis of endogeneity of the natural rate in the largest economies in Latin America.

The remainder of this paper is organized as follows. The next section briefly describes the concept of unit roots in time series and provides unit roots tests using panel data for GDP series of the twelve largest economies in Latin America. In addition, it presents alternative interpretations of unit roots regarding the relative importance of supply and demand shocks in long-run output trends. Section 3 addresses the topic of demand-led growth and estimates the endogeneity of the natural rate of growth in Latin American economies. Section 4 concludes.

2. Testing for unit roots in GDP in a panel of twelve economies in Latin America

The presence or absence of unit roots, to put it simply, helps to identify some features of the underlying data-generating process of a series. If a series has no unit roots, it is characterized as stationary, and therefore exhibits mean reversion in that it fluctuates around a constant long run mean. Also, the absence of unit roots implies that the series has a finite variance which does not depend on time (this point is crucial for economic forecasting), and that the effects of shocks dissipate over time.

Alternatively, if the series feature a unit root, they are better characterized as non-stationary processes that have no tendency to return to a long-run deterministic path. Besides, the variance of the series is time-dependent and goes to infinity as time approaches infinity, which results in serious problems for forecasting. Finally, non-stationary series suffer permanent effects from random shocks. As usually denominated in the literature, series with unit roots follow a *random walk*.

Given these different features and different implications, it is important to check whether a GDP series can be described as stationary or not. This is usually done by testing for the presence of a unit root in the autoregressive representation of the series. If a unit root is found, traditional estimation techniques cannot be used since, as is well known, spurious results are obtained when two variables with unit roots are regressed on each other: misleadingly high R squares and t statistics, and very low DW statistics.[3]

The original unit root tests (such as ADF and PP), as well as several developments that appear in the literature, are based on single-country data. Recently, attempts have been made to use panel data in unit root tests (Levin, Lin, and Chu, hereafter LLC, 2002; Im, Pesaran, and Shin, hereafter IPS, 2003; Hadri, 2000). In general, the use of panel data is seen as a means of generating more powerful unit root tests, and panel data techniques have been recently applied in testing for unit roots in output, inflation rates, unemployment, and nominal interest rates.

The empirical literature on the existence of unit roots in GNP time series concentrates mainly on developed countries, but recently a growing number of studies are addressing the issue of unit roots in developing economies. In the case of Latin America, single-country studies have tested for unit roots in GDP using different techniques, and a brief review of this empirical literature shows no conclusive result[4]. One of the reasons for this outcome is the low power of unit root tests, and the responsiveness of its results to a number of influences.

In this section, I will use panel data from Latin American countries to estimate whether GDP series present a unit root. The use of panel data allows for an increase in the power of unit root tests and may therefore improve the reliability of its results.

In this study, three different tests will be presented. First, the LLC test (Levin, Lin and Chu, 2002) which assumes that all individuals in the panel have identical first-order partial autocorrelation coefficients, but other parameters such as the degree of persistence in individual regression error, the intercept and trend coefficients are allowed to vary freely across individuals. Their test procedures are designed to assess the null hypothesis that each individual in the panel has non-stationary time series, versus the alternative hypothesis, that all individuals' time series are stationary. The LLC test considers the following ADF specification:

3 A complete description of unit root tests is beyond the scope of this article. For an extensive presentation and discussion of unit root tests, see Maddala and Kim (1998).

4 See Libanio (2005).

$$\Delta y_{it} = \alpha_i + \beta y_{i,t-1} + \gamma_i t + \sum_{j=1}^{k} \delta_{ij} \Delta y_{i,t-j} + \varepsilon_{it} \tag{1}$$

Note that this specification includes intercept and time trend, but I will also test without these. As mentioned before, LLC restricts first-order partial autocorrelation coefficients (β) to be identical across countries, but allow the lag order for the difference terms to be different for each country. The $\Delta y_{i,t-j}$ terms on the right-hand side allow for serial correlation and ensure that ε_{it} is white noise. The null hypothesis of unit roots is $\beta = 0$ will be tested against the stationary alternative that $\beta < 0$.

The second test to be presented is IPS (Im, Pesaran, and Shin, 2003), which allows the first order AR coefficient to differ across countries under the alternative hypothesis, and specifies a separate ADF regression for each country:

$$\Delta y_{it} = \alpha_i + \beta_i y_{i,t-1} + \gamma_i t + \sum_{j=1}^{k} \delta_{ij} \Delta y_{i,t-j} + \varepsilon_{it} \tag{2}$$

In this case, the null hypothesis is $\beta_i = 0$ for all i, whereas the alternative is $\beta_i < 0$ for some of the series. This test will also be performed with and without intercept and trend.

Both LLC and IPS have unit root as the null hypothesis. Alternatively, the Hadri panel unit root test (Hadri, 2000), assumes individual observed series to be stationary under the null hypothesis, against the alternative of a unit root in panel data. This test is the also presented in the paper and is based on the residuals from the individual OLS regressions on a constant and a trend.[5]

The sample consists on the twelve largest economies in Latin America: Argentina, Brazil, Chile, Colombia, Costa Rica, Dominican Republic, Ecuador, Guatemala, Mexico, Peru, Uruguay and Venezuela. The selection of these countries is somehow arbitrary but still comprehensive, since the sample represents more than 90% of total GDP in Latin America and the Caribbean. Also, excluding the smallest economies of the region from the study increases the homogeneity of the sample with respect to the size of the economies[6]. It is not clear whether size matters for stationarity of GDP, and the literature on unit roots does not address this issue. However, one could argue that larger economies cannot be adequately described by the assumptions of small-open-economies, and therefore may present higher degree of persistency to external shocks. If this is the case, it is

5 A detailed description of the test procedures developed by Hadri, LLC and IPS is beyond the scope of this article. See the original references for more details.

6 The largest economy in this sample, Brazil, is approximately fifty times larger than the smallest, Costa Rica. On the other hand, fourteen of the countries in the region, not included in the sample, have a GDP which is at least 100 times smaller than Brazilian GDP.

possible that the behavior of output series differs between small and large countries, and the latter group is more likely to present unit roots in GDP series.

Since unit root tests are usually sensitive to specification and the choice of sample, this paper presents tests using different sample sizes, in order to check for robustness. Tests are performed for the five, seven, ten and twelve largest economies in the region. Annual data from ECLAC, over the period 1970-2004, has been used to perform the unit roots tests. The use of a single source intends to assure data comparability across countries. GDP is measured in constant 1995 US dollars.

Some of the test results are provided in tables 1 to 4, and support the hypothesis that GDP series in Latin America are non stationary. In all cases, LLC and IPS fail to reject the null of unit root, whereas Hadri rejects the null of stationarity in favor of a unit root[7].

TABLE 1
PANEL DATA UNIT ROOT TESTS: 12 COUNTRIES
ARGENTINA, BRAZIL, CHILE, COLOMBIA, COSTA RICA, DOMINICAN REPUBLIC, ECUADOR, GUATEMALA, MEXICO, PERU, URUGUAY, VENEZUELA
1970-2004

Exogenous variables: Individual effects
Automatic selection of maximum lags
Automatic selection of lags based on SIC: 0 to 4
Newey-West bandwidth selection using Bartlett kernel

Method	Statistic	Prob.**	Cross-sections	Obs
Levin, Lin & Chu t*	3.4954	0.9998	12	397
Null: Unit root (assumes common unit root process)				
Im, Pesaran and Shin W-stat	6.3787	1	12	397
Null: Unit root (assumes individual unit root process)				
Hadri Z-stat	12.2344	0	12	420
Null: No unit root (assumes common unit root process)				

** Probabilities for tests are computed assuming asymptotic normality.

Source: ECLAC – Economic Commission for Latin America and the Caribbean

7 These results assume individual intercepts. I also performed tests with intercept and time trend. Results were similar to the ones in tables 1-4, except for the IPS statistic in the samples with ten, seven and five countries, which suggested the rejection of the unit roots null. In addition, tests were performed for the first difference of the series, and the results indicate that all the series are AR(1). These results will not be presented here due to space constraints, but can be made available upon request.

TABLE 2
PANEL DATA UNIT ROOT TESTS: 10 COUNTRIES
ARGENTINA, BRAZIL, CHILE, COLOMBIA, ECUADOR, GUATEMALA, MEXICO, PERU, URUGUAY, VENEZUELA
1970-2004

Exogenous variables: Individual effects
Automatic selection of maximum lags
Automatic selection of lags based on SIC: 0 to 4
Newey-West bandwidth selection using Bartlett kernel

Method	Statistic	Prob.**	Cross-sections	Obs
Levin, Lin & Chu t*	1.8884	0.9705	10	331
Null: Unit root (assumes common unit root process)				
Im, Pesaran and Shin W-stat	4.5096	1	10	331
Null: Unit root (assumes individual unit root process)				
Hadri Z-stat	11.1689	0	10	350
Null: No unit root (assumes common unit root process)				

** Probabilities for tests are computed assuming asymptotic normality.

Source: ECLAC – Economic Commission for Latin America and the Caribbean.

TABLE 3
PANEL DATA UNIT ROOT TESTS: 7 COUNTRIES
ARGENTINA, BRAZIL, CHILE, COLOMBIA, MEXICO, PERU, VENEZUELA
1970-2004

Exogenous variables: Individual effects
Automatic selection of maximum lags
Automatic selection of lags based on SIC: 0 to 4
Newey-West bandwidth selection using Bartlett kernel

Method	Statistic	Prob.**	Cross-sections	Obs
Levin, Lin & Chu t*	1.9867	0.9765	7	233
Null: Unit root (assumes common unit root process)				
Im, Pesaran and Shin W-stat	4.1922	1	7	233
Null: Unit root (assumes individual unit root process)				
Hadri Z-stat	9.3441	0	7	245
Null: No unit root (assumes common unit root process)				

** Probabilities for tests are computed assuming asymptotic normality.

Source: ECLAC – Economic Commission for Latin America and the Caribbean

TABLE 4
PANEL DATA UNIT ROOT TESTS: 5 COUNTRIES
ARGENTINA, BRAZIL, CHILE, COLOMBIA, MEXICO
1970-2004

Exogenous variables: Individual effects
Automatic selection of maximum lags
Automatic selection of lags based on SIC: 0 to 4
Newey-West bandwidth selection using Bartlett kernel

Method	Statistic	Prob.**	Cross-sections	Obs
Levin, Lin & Chu t*	1.9549	0.9747	5	166
Null: Unit root (assumes common unit root process)				
Im, Pesaran and Shin W-stat	4.2398	1	5	166
Null: Unit root (assumes individual unit root process)				
Hadri Z-stat	7.8996	0	5	175
Null: No unit root (assumes common unit root process)				

** Probabilities for tests are computed assuming asymptotic normality.

Source: ECLAC – Economic Commission for Latin America and the Caribbean

The results presented in tables 1 to 4 suggest that GDP series are non-stationary in the major economies in Latin America. Therefore, output shocks – both from the supply side and the demand side – are expected to have persistent effects in the economy. In this sense, unit roots in GDP series pose a challenge for traditional theories of macroeconomic fluctuations, which assume shocks to have only temporary real effects and output to be mean-reverting (towards, say, the natural rate of unemployment).

2.1 Unit roots and supply-side shocks

At first, evidence of unit roots in GDP time series was used to provide support for theories of fluctuations based on real (as opposed to monetary) factors. This argument is present in the work of Nelson and Plosser (1982), and has strongly influenced the direction of macroeconomic research within the mainstream since the 1980s[8]. It is clear, however, that it depends on the assumption that demand shocks are necessarily temporary and so can only affect the cyclical component, and that the long run path of the economy is mainly guided by real factors such as tastes and technology.

[8] The main effect can be seen as the advance of real business cycle models and the decline of new classical models – developed by Lucas, Sargent, and Barro, among others, during the 1970s – in which monetary misperceptions were considered the major source of output fluctuations.

In other words, the classical dichotomy between real and monetary variables is assumed. In particular, it is assumed that the cyclical component is stationary, and mainly affected by monetary factors, which are neutral in the long run. In this respect, Nelson and Plosser acknowledge in a footnote that the theoretical possibility of a "Tobin effect" of sustained inflation on the steady-state capital stock is ignored in their analysis. It is clear that once money is allowed to play any significant role in the long run path of the economy, unit roots do not necessarily support RBC theories. In addition, concerning the stationarity of the cyclical component, Nelson and Plosser admit it is a proposition that cannot be inferred from empirical analysis. However, they justify its use by saying that it is an assumption "we believe most economists would accept." (Nelson and Plosser, 1982, p. 160)

The first reactions to the conclusions of Nelson and Plosser can be seen as an attempt to support new Keynesian models of aggregate fluctuations, in which GDP is expected to revert to a long-run trend, but in which the adjustment process can be very slow due to imperfections in goods and labor markets. A number of papers were published during the 1980s with different arguments in this direction, suggesting that demand shocks do not affect the natural rate of output, and have effects that dissipate in the long run, even though the adjustment process may be slow due to rigidities and market imperfections (McCallum, 1986; Campbell and Mankiw, 1987; West, 1988).

2.2 Unit roots and the role of aggregate demand on growth

The existence of unit roots in GNP time series and the consequent persistence of shocks can also be used to support different non-mainstream views of economic fluctuations and economic growth, which emphasize the importance of aggregate demand and existence of multiple equilibria with the possibility of persistent involuntary unemployment, due to path dependence, hysteresis in labor markets, and non-neutrality of money in the long run, among other considerations.

In general terms, it can be argued that many theories in which aggregate demand influences the long run equilibrium of the economy, or in which the concept of a natural rate of unemployment (unique and stable) is discarded, are compatible with the presence of unit roots in GDP. Examples include the type of multiple equilibria models developed by Hahn and Solow (1995), structuralist models *a la* Taylor (1991), and the Keynes-post Keynesian approach to macroeconomics.

This paper argues that the presence of unit roots in macroeconomic time series provide support to the general perspective adopted by Keynes and post Keynesians on output and employment fluctuations, on the non-neutrality of money in the long run, and on some economic policy issues. Therefore, this paper agrees with Cross (1993, p. 307) when he says that "tests for unit roots (…) have surely offered insights into the nature of macroeconomic processes which do not entirely conflict with post Keynesian views."

In this case, a demand-oriented response to Nelson and Plosser's interpretation would consider a different set of assumptions and entail a completely different perspective on how actual monetary economies work. In fact, the features of non-stationary GDP series were taken by Nelson and Plosser (1982) as supporting RBC models, but they are also entirely compatible with a post Keynesian view of how the real world works.

First of all, under the post Keynesian paradigm, it is recognized that actual capitalist economies function in historical time. That is to say, economic events take place in a unidirectional sequence rather than instantaneously ('time is a device that prevents everything from happening at once'), and this implies that the timing and ordering of such events affect the nature of final economic outcomes. In other words, instead of considering an economic system which adjusts inevitably towards some determinate equilibrium, Keynes and the post Keynesians take into account the idea that no equilibrium position can be independent of the trajectory of the economy towards it: history matters!

Another important aspect of post Keynesian economics is the emphasis on the uncertainty that surrounds decision-making in a non-ergodic environment. Since economic agents make production and investment decisions based on expectations about an uncertain future, disappointment of expectations or changes in the environment may lead to sudden revisions of such decisions, which affect total expenditures and therefore alter the path of the economy, defining new equilibrium positions[9]. As Davidson (1993, p. 313n) puts it: "the existence of uncertainty, *by definition*, assures that there never need exist a long-run statistical average about which the system will fluctuate as it moves from the present to an uncertain future."

The role of expectations and the possibility of multiple equilibrium positions with involuntary unemployment are clearly described in the post Keynesian literature. It is well known that Keynes used different assumptions about short run and long run expectations and their interaction. The so-called model of shifting equilibrium is considered to be Keynes's 'complete dynamic model' (Kregel, 1976, p. 215), and seems to provide the most accurate description of Keynes's views on the nature of decision-making under uncertainty. In this model, short-period expectations may be

[9] See Fazzari, Ferri and Greenberg (1998) for a model where negative shocks in aggregate demand imply changes in the optimal pricing and production decisions of firms in a monopolistically competitive environment, which lead to persistent effects in output and employment.

disappointed and hence change, and such changes also affect long-period expectations. The revision of long-term expectations given current outcomes implies, in turn, that the underlying determinants of aggregate demand (or, the fundamental psychological variables: the propensity to consume, liquidity preference, and the marginal efficiency of capital) are endogenous to the path of the economy. In this case, the long-run equilibrium will itself respond to short-run outcomes, and one should not expect the economy to converge to any predetermined path. According to Kregel (1976, p.217),

> "if (…) realization of errors alters the state of expectations and shifts the independent behavioral functions, Keynes's model of shifting equilibrium will describe an actual path of the economy over time chasing an ever changing equilibrium – it need never catch it."

On the other hand, persistence of demand shocks is a natural implication of post Keynesian models, and it does not come as a surprise. Moreover, once the assumption of money neutrality is discarded, and the interdependence of real and monetary sectors is considered, the claim that real (technology) shocks are the only phenomena responsible for fluctuations in the long run does not make any sense. In the real world, money matters in the short and long run, and non-stationarity may be related to changes in monetary or real variables and the consequent revision of expectations by economic agents[10].

3 The endogeneity of the natural rate of growth

As discussed in the previous section, the presence of unit roots suggests that economic fluctuations have persistent effects on the secular trend of the economy. However, it does not assess the relative importance of demand and supply shocks in explaining long-run growth rates. At first, evidence of unit roots in GNP time series was used to provide support for theories of fluctuations based on technology (supply) shocks, yet it is also compatible with persistent aggregate demand shocks. This section intends to shed light on the relative importance of aggregate demand shocks in explaining long-run growth rates, by testing the hypothesis of endogenous natural rate of growth for a sample of Latin American countries.

The concept of a natural rate of growth was first introduced by Harrod (1939), who defined it as "the maximum rate of growth allowed by the increase of population, accumulation of capital, technological improvement and the work/leisure preference schedule" (Harrod, 1939, p. 30). In other words, the natural rate refers to the growth of potential output in the economy and can be

[10] Note that 'external' shocks are not a necessary condition for economic fluctuations. In the post Keynesian literature, there are many well-known attempts to explain fluctuations and instability that are endogenous to the system (for example, Minsky's financial instability hypothesis; Minsky [1986]). Also, money is considered to be endogenous, and therefore the idea of a 'monetary shock' cannot be directly transferred without some adaptation.

defined as the sum of the growth rates of the labor force and of labor productivity. In Harrod, as well as in neoclassical growth models, the natural rate is treated as exogenous and is entirely independent of demand forces in the economy[11].

From a demand-oriented perspective, however, it can be argued that the natural rate of growth is endogenously determined in that it responds to the actual rates of economic growth. In this case, aggregate demand influences the long-run trend of output since it affects both labor supply and labor productivity by a number of channels. Regarding the growth of labor force, demand affects the decisions of potential workers to enter the workforce, and participation rates tend to increase in periods of high economic growth, and decrease during recessions. Particularly in the case of developing countries, informal sectors tend to absorb workers expelled from formal employment during slumps and provide additional labor force to the formal sector in periods of expansion. In addition, the number of hours worked respond to demand, and migration patterns may also be affected by high growth rates in specific regions.

On the other hand, aggregate demand influences the trend of labor productivity. First, it affects firms' decisions to invest and thus impinge on the pace of capital accumulation. Consequently, to the extent that technical progress is embodied in capital, demand has an effect on technology and factor productivity. Also, increasing levels of demand promote higher productivity due to the existence of static and dynamic returns to scale in the economy, captured by the so-called Verdoorn's Law (Kaldor, 1966). Finally, demand impacts labor productivity by affecting the level of skills of the labor force via "learning by doing".

In sum, the endogeneity of the natural rate of growth means that economic growth is demand-led because technological change, productivity and the supply of labor respond to aggregate demand growth. Besides, if the natural rate is endogenous, an important implication is that the level of potential output at full employment cannot be taken as a *given* point towards which the economy will converge. Instead, it will move continuously with the actual growth rate. It is worth noting that this dynamics is in line with some of the discussion made in previous sections of this paper regarding the existence of unit roots in output series and Keynes's model of shifting equilibrium.

This essay intends to test the hypothesis of endogenous natural rate for Latin American countries. In other words, it estimates the sensitivity of the natural rate of growth to the actual rate of growth. One of the limitations of this study derives from the fact that open unemployment rates may not be

[11] See Hahn and Solow (1995) and Fatas (2000) for neoclassical models in which aggregate demand influences growth. See Dutt (2004) and Bhaduri (2006) for non-neoclassical endogenous growth models.

the ideal indicator to reflect labor market conditions in Latin America, given the importance of informal sectors in these economies. However, no reliable data on employment in informal sectors is available for the countries studied here, and the results should be taken as reflecting the evolution of employment in the formal sector.

For estimation purposes, the natural rate of growth can be defined as the rate that keeps unemployment constant, for unemployment would decrease if the actual growth rate was above the natural rate, and increase otherwise[12].

Thirlwall (1969) presents a simple method for estimating the natural rate of growth. Following the work of Okun (1962), the percentage change in unemployment (*Δ%U*) is considered as a linear function of the growth of output (*g*):

$$\Delta\%U = a - b.(g) \tag{3}$$

This is the so-called Okun's equation, and the natural rate of growth is given by a/b, since this is the rate of growth that would result in $\Delta\%U = 0$. It is possible that the estimate of *b* is biased downwards because of labor hoarding, and also that the estimate of *a* is biased downwards due to workers leaving the labor force in periods of low growth. Alternatively, Thirlwall (1969) reverses the dependent and independent variables in equation (3), in order to overcome the bias in the estimate of *b*:

$$g = a_1 - b_1.(\Delta\%U) \tag{4}$$

In this equation (henceforth Thirlwall's equation), the natural rate of growth is given by the constant term a_1, and therefore the bias relating to labor hoarding in equation (3) will not affect the estimation of the natural rate of growth. However, the coefficient estimates in Thirlwall's equation are also statistically biased since $\Delta\%U$ is not an exogenous variable.

In this study, the natural rate has been estimated by both methods to assure robustness of the results. The sample is about the same as in the unit root tests: Argentina, Brazil, Chile, Colombia, Costa Rica, Ecuador, Mexico, Peru, Uruguay and Venezuela. Dominican Republic and Guatemala were excluded from the original sample due to lack of data for part of the sample period. For the estimation of the natural rate of growth, I used data from ECLAC for the period 1980-2004.

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[12] The same definition is used by Leon-Ledesma and Thirlwall (2002).

The results of the OLS estimation of Okun's equation appear in table 5. The model is jointly significant at 95% for all countries except Ecuador. Among the remaining nine countries in the sample, the estimation of the natural rate of growth (a/b) is significant in all but Argentina and Peru, and range from 2.24% (Uruguay) to 4.10% (Chile).

Table 6 reports the results of estimating the natural rate using Thirlwall's equation. In this case, the model is jointly significant for all countries but Ecuador, and the estimated natural rate of growth is significant for all countries but Argentina. Also here, Uruguay and Chile present the lowest and highest natural rates (1.81% and 4.42%, respectively).

TABLE 5
ESTIMATION OF THE NATURAL RATE OF GROWTH: OKUN'S EQUATION
SELECTED LATIN AMERICAN COUNTRIES
1980/2004

Country	Constant	Coef. on GDP growth	R^2 [d]	DW	Natural Rate[e]
Argentina[a,b]	0.9064 (1.269)	-0.2221 (-4.036)*	0.455*	-	4.08 (1.512)
Brazil[b]	0.4281 (2.189)*	-0.1890 (-3.750)*	0.413*	2.037	2.27 (6.680)*
Chile	1.9527 (4.327)*	-0.4758 (-6.699)*	0.671*	2.292	4.10 (35.247)*
Colombia	1.5530 (3.319)*	-0.4402 (-3.454)*	0.352*	1.455	3.53 (32.023)*
Costa Rica	0.6851 (2.115)*	-0.1763 (-2.802)*	0.262*	2.095	3.89 (3.886)*
Ecuador	0.3678 (0.762)	-0.0629 (-0.540)	0.013	1.981	5.85 (0.415)
Mexico[c]	0.4323 (2.409)*	-0.1604 (-3.849)*	0.402*	1.442	2.70 (8.681)*
Peru	0.3763 (1.278)	-0.1457 (-3.120)*	0.307*	2.527	2.58 (1.778)
Uruguay	0.5626 (2.000)**	-0.2517 (-5.142)*	0.546*	1.663	2.24 (4.096)*
Venezuela[a]	0.7233 (2.079)**	-0.2151 (-5.668)*	0.632*	-	3.36 (4.388)*

Source: World Bank – WDI
Notes:
* Significant at 95%, ** Significant at 90%, t-statistics are in parenthesis
a. Estimated using AR(1) iterative procedure due to evidence of residual autocorrelation.
b. Period 1980-2002
c. Data may not be comparable before and after 1997 due to a change in methodology. Therefore, results for Mexico should be viewed with caution.
d. Significance based on F-test of joint significance
e. Significance based on a Wald Test, distributed as a Chi-Square (1).

It is worth noting that the estimated natural rates are similar using both equations[13]. The average difference is 0.44 percentage points, and only in the case of Argentina it is greater than 1 (one)

[13] Leon-Ledesma and Thirlwall (2002) provide estimations for 15 OECD countries over the period 1961-1995 and also find similar results using both approaches. To the best of my knowledge, no similar estimation has been made for developing countries.

percentage point[14]. In addition, I estimated Thirlwall's equation by two-stage least squares using the lags of the variables as instruments, in order to deal with the problem of endogeneity of $\Delta\%U$. In most of the cases the results were similar to the OLS estimation[15], suggesting that the bias is not relevant for the results[16].

TABLE 6
ESTIMATION OF THE NATURAL RATE OF GROWTH: THIRLWALL'S EQUATION
SELECTED LATIN AMERICAN COUNTRIES
1980/2004

Country	Constant	Coefficient on Δ%U	$R^{2\ d}$	DW	Natural Rate
Argentina[a,b]	2.2540 (0.825)	-2.1749 (-4.153)*	0.517*	-	2.250
Brazil[b]	2.1522 (3.826)*	-2.1843 (-3.750)*	0.413*	1.433	2.152
Chile[a]	4.4223 (3.784)*	-1.5576 (-5.764)*	0.438*	-	4.422
Colombia[a]	3.3369 (5.216)*	-0.7493 (-3.635)*	0.538*	-	3.337
Costa Rica	3.7643 (5.779)*	-1.4917 (-2.802)*	0.263*	1.589	3.764
Ecuador	2.3835 (3.261)*	-0.2082 (-0.540)	0.013	2.283	2.383
Mexico[c]	2.5711 (4.435)*	-2.5088 (-3.849)*	0.402*	1.506	2.571
Peru	2.1267 (1.991)**	-2.1051 (-3.120)*	0.307*	1.403	2.127
Uruguay	1.8067 (2.228)*	-2.1685 (-5.142)*	0.546*	1.629	1.807
Venezuela	2.3616 (2.672)*	-2.7182 (-5.707)*	0.597*	1.723	2.362

Source: World Bank – WDI
Notes: Same as in Table 5.
For Chile, AR(2) errors were used.

The natural rate of growth estimated by OLS using Thirlwall's equation (as it appears in table 6) was then used to test for endogeneity. This can be done by calculating deviations of the actual growth rate from the natural rate, and introducing a dummy variable ($D = 1$) for periods when the former exceeds the later, and zero otherwise:

$$g = a_2 + b_2 D - c_2(\Delta\%U) \qquad (5)$$

The intuition behind this procedure is illustrated in figure 1. The intercept a_1 corresponds to the natural rate of growth for the entire sample period, not distinguishing periods of expansion and recession. When separating periods when $g > g_n$ and $g < g_n$, the question is whether the intercepts

14 These results exclude Ecuador, where the model appears not to be significant.

15 Except for Argentina and Venezuela, where some differences were found. Also in this case, the model was not significant for Ecuador.

16 Similar results were found by Leon-Ledesma and Thirlwall (2002).

differ or not. If they do differ, it means that the natural rate of growth is higher in booms ($a_2 + b_2$) than in slumps (a_2), and therefore it is endogenous[17].

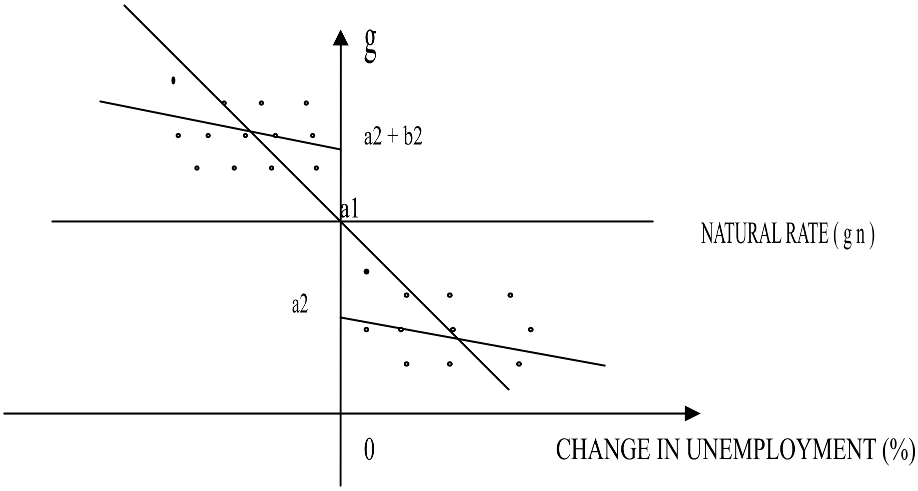

Figure 1. Natural rate responds to the actual rate of growth

Source: Ledesma and Thirlwall (2002).

In practice, observations in the top right and bottom left quadrants are also possible, since the relation between economic growth and change in unemployment is stochastic, and these 'abnormal' observations may bias the estimates of a_2 and b_2. In this study, the proportion of 'abnormal' observations for each country in the sample is: Argentina (26%); Brazil (26%); Chile (33%); Colombia (42%); Costa Rica (25%); Ecuador (38%); Mexico (33%); Peru (25%); Uruguay (38%); Venezuela (17%). The possibility of having biased coefficients is tested for by including a dummy taking the value 1 for each set of 'abnormal' points. If the dummy is significant, observations in the top right and bottom left quadrants are relevant and bias the estimates. This test shows that only in the case of Colombia and Uruguay the dummy for observations in the top right quadrant is significant and may bias the intercept estimates upwards. For the other countries in the sample, the existence of abnormal points does not seem to affect the estimations of the natural rate in periods of expansion.

Alternatively, I have estimated equation (5) using another definition of booming periods, in order to capture long-run effects. In this case, the dummy takes the value of 1 in years when a three year

[17] Note that a supply-side interpretation can also be given to the negative relation between growth rates and changes in unemployment (equation 12). In this case, positive "exogenous" technology shocks increase growth rates and may reduce unemployment if expectations of productivity growth respond slowly to changes in actual productivity, since this would lead to real wages below equilibrium and consequently higher labor demand and employment. For a textbook presentation of this mechanism, see Blanchard (1997, chapter 25). According to the demand-led growth perspective adopted in this study, however, technical change itself is also responsive to actual growth rates.

moving average of growth rates is above the average growth for the entire period. Note that this definition is independent of the estimation of the natural rate using either equation (3) or (4).

In both definitions of booming periods, if the coefficient on the dummy (b_2) plus the constant (a_2) is significantly higher than the original constant (a_1) in equation (4), this means that the rate of growth to keep unemployment constant in booms must have risen. In other words, the actual rate of growth must have pulled up the natural rate. Such result suggests that aggregate demand influences the growth of labor supply and labor productivity and, therefore, affects the growth rates of the economy in the long run.

The results of the estimations are presented in tables 7 and 8. The dummies are significant at 95% in almost all the cases, and the results show that for all countries the natural rate of growth in periods of boom is higher than average. Using the first dummy specification, the natural rate in booms presents increases ranging from 30% to 188% across the sample and it is on average twice as high as the natural rate in the entire period. If we use the second specification, the natural rate increases between 24% and 144% in periods of expansion, and it is on average 73% higher (table 9).

TABLE 7
ESTIMATION OF THE CHANGE IN NATURAL RATE OF GROWTH (1)
SELECTED LATIN AMERICAN COUNTRIES
1980/2004

Country	Constant	Dummy[d]	Coeffic. on Δ%U	R^2 [e]	DW
Argentina[b]	-1.6942 (-1.472)	7.9397 (4.830)*	-1.0108 (-2.174)*	0.672*	2.081
Brazil[b]	-0.0205 (-0.037)	4.2784 (5.335)*	-1.2656 (-3.046)*	0.765*	1.568
Chile[a]	2.3874 (2.747)*	4.2277 (5.336)*	-1.0589 (-5.132)*	0.791*	-
Colombia	1.8999 (4.533)*	2.4518 (4.114)*	-0.4850 (-2.528)*	0.641*	1.931
Costa Rica	0.9766 (1.316)	4.7473 (4.791)*	-0.8560 (-2.144)*	0.648*	1.935
Ecuador	-0.4147 (-0.492)	4.7632 (4.344)*	-0.1191 (-0.415)	0.480*	2.674
Mexico[c]	-0.0979 (-0.134)	4.5013 (4.463)*	-1.2105 (-2.163)*	0.693*	1.546
Peru	-3.1466 (-2.192)*	8.2446 (4.396)*	-0.8480 (-1.476)	0.639*	2.063
Uruguay	-1.4359 (-1.856)**	6.6559 (5.673)*	-1.3601 (-4.439)*	0.821*	1.959
Venezuela	-1.3971 (-1.165)	7.0890 (3.840)*	-1.4029 (-2.768)*	0.763*	1.248

Source: World Bank – WDI
Notes:
* Significant at 95%, ** Significant at 90%, t-statistics are in parenthesis
a. Estimated using AR(1) iterative procedure due to evidence of residual autocorrelation. In the case of Chile, AR(2) errors were used.
b. Period 1980-2002
c. Data may not be comparable before and after 1997 due to a change in methodology.
Therefore, results for Mexico should be viewed with caution.
d. Dummy takes the value 1 in periods when actual growth is above the natural rate of growth and 0 otherwise.
e. Significance is based on F-test of joint significance.

TABLE 8
ESTIMATION OF THE CHANGE IN NATURAL RATE OF GROWTH (2)
SELECTED LATIN AMERICAN COUNTRIES
1981/2003

Country	Constant	Dummy [d]	Coefficient on Δ%U	R^2 [e]	DW
Argentina[b]	-1.5549 (-1.272)	7.0604 (4.354)*	-1.5530 (-3.329)*	0.634*	1.72
Brazil [b]	0.7256 (1.336)	3.8536 (4.127)*	-1.4902 (-3.202)*	0.690*	1.867
Chile	2.3471 (3.022)*	3.1229 (2.922)*	-1.2251 (-6.339)*	0.776*	1.935
Colombia	1.8800 (4.416)*	2.4360 (4.203)*	-0.6078 (-3.259)*	0.653*	2.049
Costa Rica	1.6042 (1.400)	3.2575 (2.229)*	-0.9419 (-1.691)	0.410*	2.129
Ecuador [a]	0.4321 (0.654)	3.3722 (3.278)*	-0.3416 (-1.199)	0.388*	-
Mexico [c]	0.9166 (1.447)	3.4635 (3.544)*	-2.1597 (-3.996)*	0.655*	2.152
Peru	-2.1912 (-1.581)	6.8588 (3.866)*	-1.8374 (-3.426)*	0.604*	2.458
Uruguay	-1.7743 (-1.590)	5.5629 (3.830)*	-1.3482 (-3.275)*	0.691*	2.67
Venezuela	0.7679 (0.680)	2.3404 (1.350)	-2.1021 (-4.306)*	0.583*	1.857

Source: World Bank – WDI
Notes:
* Significant at 95%, ** Significant at 90%, t-statistics are in parenthesis
a. Estimated using AR(1) iterative procedure due to evidence of residual autocorrelation.
b. Period 1981-2002
c. Data may not be comparable before and after 1997 due to a change in methodology. Therefore, results for Mexico should be viewed with caution.
d. Dummy takes the value 1 (one) in years in which a three year moving average of growth rates is above the average growth, and 0 (zero) otherwise.
e. Significance is based on F-test of joint significance.

A similar analysis can be done for periods of slump. If the natural rate of growth is endogenous, it may be reduced during recessions. As mentioned before, the natural rate in periods of slump is illustrated by the coefficient a_2 in figure 1, and therefore it corresponds to the constant presented in the first column of tables 7 and 8. The results show for all countries that the natural rate has declined in periods of low growth. The average fall of the natural rate across the sample is 125% in the case of the first specification, and 100% using the second specification[18].

It is interesting to compare the results presented in this paper to the ones provided by Leon-Ledesma and Thirlwall (2002) for 15 developed countries. In particular, it is clear that the natural rate of growth in Latin America responds much more strongly to movements in the actual rates of growth than the countries in Leon-Ledesma and Thirlwall's sample[19]. There are two possible explanations for this result. The first one relates to the importance of informal markets in the

[18] Calculations are not presented here but can be made available upon request.

[19] The natural rate increases by 103% or 73% in Latin America (depending on the specification), whereas the correspondent numbers for the 15 OECD countries are 52% and 40%. So it can be said that the natural rate is about twice as sensitive to the actual growth rates in the Latin American sample.

developing world, which function as a reserve of labor to be used in periods of expansion. In this sense, it is fair to say that labor markets in Latin America are more “flexible” due to the movement of workers from informal to formal sectors (and vice-versa) in different phases of the cycle. The second explanation relates to the effects of output growth on productivity (captured by the Verdoorn’s Law) which are likely to be more significant in countries that are not industrially ‘mature’ (Kaldor, 1966).

Another interesting result is obtained when periods of boom and slump are compared: in Latin America, the movement of the natural rate of growth seems to be asymmetrical over the cycle, since the decline in periods of recession is on average larger than the increase in periods of expansion. On the other hand, similar calculations in the results provided by Leon-Ledesma and Thirlwall (2002) show that the natural rate reacts symmetrically to booms and slumps in industrialized countries. Such differences may also be explained by the same factors mentioned before, and it can be argued that the negative effects of recessions on the growth of labor supply and productivity are not fully compensated by equivalent periods of expansion. This result supports the idea that recessions have long-lasting and sometimes irreversible effects on output and employment, and reinforces some of the arguments made by Dutt and Ros (2003) against the promotion of sharp contractions in response to financial or currency crises in the developing world.

In sum, all the results presented here provide substantial evidence in favor of the hypothesis that the natural growth rate is endogenous and, therefore, that the potential output trend respond to aggregate demand fluctuations in the long run.

4 Conclusion

This paper addressed two major questions in the relation between business cycles and economic growth. The first one relates to the non-stationarity of GDP and the existence of unit roots in output time series. The second issue discussed here refers to the endogeneity of the natural rate of growth and the relative importance of aggregate demand and supply in the determination of growth rates in the long run.

Concerning non-stationarity of GDP, the paper presented alternative interpretations for the presence of unit roots, and provided panel data unit root tests for a sample of twelve Latin American countries. The results suggest that GDP series are non-stationary and therefore that shocks may have persistent effects in the economy.

Unit root tests indicate that shocks are persistent, but do not address the question of whether supply-side or demand-side shocks are the main influence that drives output in the long run. The paper tries to address this issue by estimating the endogeneity of the natural rate of growth for the same sample of countries in Latin America. The natural rate corresponds to the growth of labor supply and labor productivity, and the estimations provided in the paper suggest that these elements respond to the movements of the actual rate of growth. In addition, it has been shown that the sensitivity of the natural rate to demand and output growth is stronger in Latin America than it is in industrialized countries, which is probably related to the importance of informal sectors and the lower industrial 'maturity' of developing economies. Finally, our results suggest that the movement of the natural rate of growth is asymmetrical over the business cycle, being the decline in periods of recession larger on average than the increase in periods of expansion.

The main implication of this study for growth theory is that it is misleading to treat growth as entirely determined by supply-side variables, since aggregate demand and output growth influences the trajectory of labor supply and productivity in the long run. In terms of economic policy, on the other hand, it is possible to make a case against sharp contractions as a response to financial or currency crises in emerging economies, as is usually implicit in the recommendations of the IMF and other international financial institutions (Dutt and Ros, 2003). In this case, the negative effects of such policies do not tend to dissipate in the short run, and are not likely to be fully offset by future expansions of same magnitude.

TABLE 9
SENSITIVITY OF THE NATURAL RATE TO THE ACTUAL RATE OF GROWTH
SELECTED LATIN AMERICAN COUNTRIES
1981-2003

Country	Natural Rate	Natural Rate (Boom)[a]	Abs. difference	% increase	Natural Rate (Boom)[b]	Abs. difference	% increase
Argentina	2.254	6.246	3.992	177.09	5.506	3.252	144.25
Brazil	2.152	4.258	2.106	97.86	4.579	2.427	112.79
Chile	4.422	6.615	2.193	49.60	5.470	1.048	23.70
Colombia	3.337	4.352	1.015	30.41	4.316	0.979	29.34
Costa Rica	3.764	5.724	1.960	52.07	4.862	1.098	29.16
Ecuador	2.383	4.349	1.966	82.48	3.804	1.421	59.64
Mexico	2.571	4.403	1.832	71.27	4.380	1.809	70.37
Peru	2.127	5.098	2.971	139.68	4.668	2.541	119.45
Uruguay	1.807	5.220	3.413	188.88	3.789	1.982	109.66
Venezuela	2.362	5.692	3.330	140.98	3.108	0.746	31.60
Average			2.478	103.03		1.730	73.00

Source: World Bank - WDI
Notes:
a. Corresponds to sum of constant and dummy coefficients in table 1.7; period 1980-2004.
b. Corresponds to sum of constant and dummy coefficients in table 1.8; period 1981-2003.

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