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Aggregate demand and the endogeneity of the natural rate of growth: evidence from Latin American economies

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This paper aims to explore the Keynesian idea that aggregate demand matters for economic activity, both in the short and 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 12 Latin American countries using panel data. The results suggest that gross domestic product series are non-stationary and therefore shocks (both from supply and demand) have persistent effects in the economy. The second exercise tests the hypothesis of an endogenous natural rate of growth, and suggests that potential output has been influenced by the actual level of economic activity in Latin American countries. This result corroborates the hypothesis that aggregate demand has long-run effects in the economy.

Key words: Natural rate of growth, Aggregate demand, Endogeneity
JEL classification: E10, E32, O40

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 has arisen as a consequence of two major theoretical developments within the mainstream. The first 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 behaviour into long-run trends and fluctuations around the trend was called into question, and it was recognised that shocks can have persistent effects in the economy.

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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 behaviour 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 summarise 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,[1] 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 unit root in 12 Latin American countries using panel data techniques, which represent new developments in econometrics (see Hadri, 2000; Im *et al.*, 2003; Levin *et al.*, 2002).

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 labour 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 organised as follows. The next section briefly describes the concept of unit roots in time series and provides unit roots tests using panel data for gross domestic product (GDP) series of the 12 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 12 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 characterised 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.

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

Alternatively, if the series feature a unit root, they are better characterised 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 Durbin-Watson statistics.[1]

The original unit root tests [such as augmented Dickey–Fuller (ADF) and Phillips–Perron (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 [Hadri, 2000; Im *et al.*, 2003; Levin *et al.*, 2002]. 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 gross national product (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.[2] One of the reasons for this outcome is the low power of unit root tests, and the responsiveness of the 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:

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

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 allows 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

[1] 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).

[2] See Libanio (2005).

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:

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

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 also presented in the paper and is based on the residuals from the individual ordinary least squares (OLS) regressions on a constant and a trend.[1]

The sample consists of the 12 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 somewhat 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.[2] 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 a higher degree of persistency to external shocks. If this is the case, it is possible that the behaviour of output series will differ 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 12 largest economies in the region. Annual data from ECLAC (Economic Commission for Latin America and the Caribbean), 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, 2, 3 and 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 favour of a unit root.[3]

[1] 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 details.

[2] The largest economy in this sample, Brazil, is approximately 50 times larger than the smallest, Costa Rica. On the other hand, 14 of the countries in the region, not included in the sample, have a GDP which is at least 100 times smaller than Brazilian GDP.

[3] 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 are available from the author upon request.

Table 1. *Panel data unti root tests in 12 countries for the period 1970–2004: Argentina, Brazil, Chile, Colombia, Costa Rica, Dominican Republic, Ecuador, Guatemala, Mexico, Peru, Uruguay, Venezuela*

Exogenous variables: individual effects
Automatic selection of maximum lags
Automatic selection of lags based on Schwarz Information Criterion: 0–4
Newey–West bandwidth selection using Bartlett kernel

Method	Statistic	Probability[a]	Cross-sections	No. observations
Levin, Lin and Chu t-statistic*	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)				

[a]Probabilities for tests are computed assuming asymptotic normality.
Source: ECLAC (Economic Commission for Latin America and the Caribbean).

Table 2. *Panel data unti root tests in ten countries for the period 1970–2004: Argentina, Brazil, Chile, Colombia, Ecuador, Guatemala, Mexico, Peru, Uruguay, Venezuela*

Exogenous variables: individual effects
Automatic selection of maximum lags
Automatic selection of lags based on Schwarz Information Criterion: 0–4
Newey–West bandwidth selection using Bartlett kernel

Method	Statistic	Probability[a]	Cross-sections	No. observations
Levin, Lin and Chu t-statistic*	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)				

[a]Probabilities for tests are computed assuming asymptotic normality.
Source: ECLAC (Economic Commission for Latin America and the Caribbean).

The results presented in Tables 1–4 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

Table 3. *Panel data unti root tests in seven countries for the period 1970–2004: Argentina, Brazil, Chile, Colombia, Mexico, Peru, Venezuela*

Exogenous variables: individual effects
Automatic selection of maximum lags
Automatic selection of lags based on Schwarz Information Criterion: 0–4
Newey–West bandwidth selection using Bartlett kernel

Method	Statistic	Probability[a]	Cross-sections	No. observations
Levin, Lin and Chu t-statistic*	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)				

[a]Probabilities for tests are computed assuming asymptotic normality.
Source: ECLAC (Economic Commission for Latin America and the Caribbean).

Table 4. *Panel data unti root tests in five countries for the period 1970–2004: Argentina, Brazil, Chile, Colombia, Mexico*

Exogenous variables: individual effects
Automatic selection of maximum lags
Automatic selection of lags based on Schwarz Information Criterion: 0–4
Newey–West bandwidth selection using Bartlett kernel

Method	Statistic	Probability[a]	Cross-sections	No. observations
Levin, Lin and Chu t-statistic*	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)				

[a]Probabilities for tests are computed assuming asymptotic normality.
Source: ECLAC (Economic Commission for Latin America and the Caribbean).

the work of Nelson and Plosser (1982), and has strongly influenced the direction of macroeconomic research within the mainstream since the 1980s.[1] 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.

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

[1] 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.

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 Real Business Cycle (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 labour 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 (Campbell and Mankiw, 1987; McCallum, 1986; 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 emphasise the importance of aggregate demand and existence of multiple equilibria with the possibility of persistent involuntary unemployment, due to path dependence, hysteresis in labour 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 recognised 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 that 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.[1] 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 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.

In very general terms, it can be argued that output may be non-stationary if involuntary unemployment can occur in the economy without bringing about the operation of automatic forces that would take the system back to its full employment position. In this case, we may point to some demand-related issues which prevent the Keynes and Pigou effects from stabilising the economy in the presence of declining wages and prices.[2] First, lower money wages imply a redistribution of income from wage-earners to recipients of non-wage income, whereas falling prices imply a shift in distribution from debtors to creditors. If these groups have different propensities to consume, such changes may bring about negative effects on aggregate consumption due to an overall decline on the propensity to consume. Second, if money is endogenous, a fall in the price level may lead to lower demand for money and credit, resulting in a decrease in money supply and not necessarily in lower interest rates, as is needed for the Keynes effect to operate. Third, the effects of deflation on investment are likely to be negative due to the increasing real value of debts and contractually fixed debt obligations. This negative effect on aggregate demand may be intensified when deflation generates expectations of future deflation, given

[1] See Fazzari *et al.* (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.

[2] For a discussion of these issues, see Keynes (1936, ch. 19); Tobin (1980, ch. 1); Dutt and Ros (2007).

the decline in the expected return to capital assets. In sum, as Tobin (1980, p. 19) puts it, 'the forces which lower money wages and prices are slow and weak, and those which translate deflation or disinflation into greater real demand are uncertain.'

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.[1]

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 defined as the sum of the growth rates of the labour force and of labour 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.[2]

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 labour supply and labour productivity by a number of channels. Regarding the growth of labour force, demand affects the decisions of potential workers to enter the workforce; 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 labour 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.

[1] 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.

[2] 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.

On the other hand, aggregate demand influences the trend of labour 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 labour productivity by affecting the level of skills of the labour 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 labour 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 dynamic is in line with some of the discussion made above 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 the ideal indicator to reflect labour 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.[1]

Thirlwall (1969) presents a simple method for estimating the natural rate of growth. Following the work of Okun (1962), the percentage change in unemployment ($\Delta\%U$) 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 labour hoarding, and also that the estimate of a is biased downwards due to workers leaving the labour 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 labour 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,

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

Chile, Colombia, Costa Rica, Ecuador, Mexico, Peru, Uruguay and Venezuela. The 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.

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 ranges 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).

It is worth noting that the estimated natural rates are similar using both equations.[1] The average difference is 0.44 percentage points, and only in the case of Argentina is it greater than 1 (one) percentage point.[2] 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,[3] suggesting that the bias is not relevant for the results.[4]

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:

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

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 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.[5]

In practice, observations in the top right and bottom left quadrants of Figure 1 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] 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.

[2] These results exclude Ecuador, where the model appears not to be significant.

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

[4] Similar results were found by Leon-Ledesma and Thirlwall (2002).

[5] Note that a supply-side interpretation can also be given to the negative relation between growth rates and changes in unemployment equation 4). 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 labour demand and employment. For a textbook presentation of this mechanism, see Blanchard (2005, ch. 13). According to the demand-led growth perspective adopted in this study, however, technical change itself is also responsive to actual growth rates.

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)*

Notes: DW = Durbin-Watson.
[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).
*Significant at 95%; **significant at 90%; *t*-statistics are in parenthesis.
Source: World Bank: World Development Indicators.

Table 6. *Estimation of the natural rate of growth: Thirwall'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

Notes: DW = Durbin-Watson.
[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]Significance based on F-test of joint significance.
*Significant at 95%; **significant at 90%; *t*-statistics are in parenthesis.
Source: World Bank: World Development Indicators.

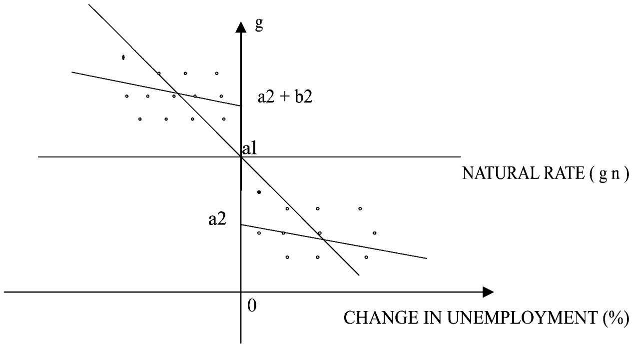

Fig. 1. *Natural rate responds to the actual rate of growth.*
Source: *Ledesma and Thirlwall (2002)*.

of 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 cases of Colombia and Uruguay is the dummy for observations in the top right quadrant significant and, thus, 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 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 equation (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 results suggests that aggregate demand influences the growth of labour supply and labour 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 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 is on average 73% higher (Table 9).

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 columns of Tables 7 and 8. The results show that the natural rate has declined in periods of low growth for all countries. 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.[1]

[1] Calculations are not presented here but are available from the author upon request.

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[a]	−1.6942 (−1.472)	7.9397 (4.830)*	−1.0108 (−2.174)*	0.672*	2.081
Brazil[a]	−0.0205 (−0.037)	4.2784 (5.335)*	−1.2656 (−3.046)*	0.765*	1.568
Chile[b]	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

Notes: DW = Durbin-Watson.
[a]Period 1980–2002.
[b]Estimated using AR(1) iterative procedure due to evidence of residual autocorrelation. In the case of Chile, AR(2) errors were used.
[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.
*Significant at 95%; **significant at 90%; t-statistics are in parenthesis.
Source: World Bank: World Development Indicators.

The results presented here suggest that aggregate demand influences economic growth in the long run, by affecting labour supply and productivity over the cycle. We may still ask if these results seem to fit the actual experience of Latin American countries in recent decades. In other words, the question in this case is whether or not demand shocks seem to have been important in driving output in the region during the period of analysis. A quick look at the evidence also suggests a positive response to this question, which can be illustrated by important growth episodes in the two major economies in South America: Argentina and Brazil. Both countries implemented successful stabilisation plans in the 1990s, and in both cases stabilisation was immediately followed by high output growth rates led by demand. In the case of Argentina, real GDP grew around 9% in the first year after stabilisation, due to rising consumption and investment spending, allowed for by the monetary expansion caused by large capital inflows.[1] In the case of Brazil, GDP also grew at high rates during the first year based mainly on consumption growth, which was driven by the expansion of consumer credit and by real income gains due to the end of inflation tax.

Given the importance of aggregate demand in driving economic growth, one of the main implications of this analysis is that growth in Latin America has been demand-constrained. The question then becomes: where do these constraints come from? Are they domestic or external? In this case, I want to argue that the external sector has played a major role in affecting the growth trajectory of Latin American economies in the last decades. This argument is supported by two elements: (i) there has been a close direct correlation between capital flows and economic activity in these countries;[2] (ii) several studies have confirmed

[1] Argentina was following a currency board regime at the time, which means that the growth of the monetary base was tied to the growth of dollar reserves in the Central Bank.

[2] Regarding the recent boom observed after 2002 in most of the region, Ocampo (2007) stresses that very favourable external financing conditions played a crucial role.

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[a]	−1.5549 (−1.272)	7.0604 (4.354)*	−1.5530 (−3.329)*	0.634*	1.72
Brazil[a]	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[b]	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

Notes: DW = Durbin-Watson.
[a]Period 1981–2002.
[b]Estimated using AR(1) iterative procedure due to evidence of residual autocorrelation.
[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.
*Significant at 95%; **significant at 90%; t-statistics are in parenthesis.
Source: World Bank: World Development Indicators.

the validity of Thirwall's Law for Latin American countries, suggesting that balance of payment issues have been central in determining economic growth rates over time.[1]

On the other hand, 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.[2] Some possible explanations for this result can be mentioned. The first relates to the importance of informal markets in the developing world, which function as a reserve of labour to be used in periods of expansion. In this sense, it is fair to say that labour 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 Verdoorn's Law) which are likely to be more significant in countries that are not industrially 'mature' (Kaldor, 1966). Third, it is possible that less-developed countries may be able to attain faster technology improvements during periods of expansion, as compared with developed economies, due to a sort of 'technological catch-up' given that developing countries are imitators/adapters rather than developers of technology.

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

[1] See, for instance, Pacheco-Lopez and Thirlwall (2006).
[2] 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.

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]	Absolute difference	Percentage increase	Natural rate (boom)[b]	Absolute difference	Percentage 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

Notes:
[a]Corresponds to sum of constant and dummy coefficients in Table 7; period 1980–2004.
[b]Corresponds to sum of constant and dummy coefficients in Table 8; period 1981–2003.
Source: World Bank: World Development Indicators.

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 industrialised countries.

Such differences may be justified by factors such as: (i) lower firing costs due to the lower wages and abundance of unskilled labour in the informal sector;[1] (ii) greater decline in human capital, due to longer episodes of unemployment caused by higher competition between workers for jobs in the formal sector; (iii) greater fragility of the institutional framework (e.g. national innovation systems) in developing countries, as compared with industrialised countries, which may intensify the adverse effects of recessions on technical change and productivity; (iv) greater fragility of domestic firms and of credit markets, which would possibly lead to larger contractions in P&D during recessions. Thus, it can be argued that the negative effects of recessions on the growth of labour 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 (2007) 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 favour of the hypothesis that the natural growth rate is endogenous and, therefore, that the potential output trend responds 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

[1] This explains the asymmetrical behaviour of firms, which tend to expand overtime work and not to increase hirings at the first signs of economic expansion, whereas they tend to dismiss workers more easily when facing recessions—we may call it 'labour un-hoarding'.

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 12 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. This article 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 labour supply and labour 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 industrialised 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, the decline in periods of recession being 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 labour 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 International Monetary Fund and other international financial institutions (Dutt and Ros, 2007). 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.

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