REGIME-DEPENDENT OUTPUT CONVERGENCE IN LATIN AMERICA*

Mark J. Holmes

Abstract

This paper tests for long-run output convergence between a sample of eight Latin American countries and over the study period 1900-2003. The key contribution of this paper is in terms of the econometric methodology where non-stationarity of log real per capita income differentials is tested within a Markov regime-switching framework. In contrast to existing studies, this paper defines two new concepts of output convergence where one allows for the possibility that output differentials behaviour either switches between stationary and non-stationary regimes (partial convergence), or switches between stationary regimes characterised by differing degrees of persistence (varied convergence). Whereas standard univariate and panel data unit root testing clearly suggest that output differentials are non-stationary, employment of the regime-switching methodology indicates that most of the sample is characterised by the existence of two distinct stationary regimes. Furthermore, it is argued that the often-cited convergence rate of two per cent per annum is likely to be an underestimate.

Resumen

Este artículo evalúa la convergencia en el producto de largo plazo entre una muestra de ocho países latinoamericanos en el período 1900-2003. La contribución clave de este trabajo es en términos de la metodología econométrica, donde la no estacionariedad de los diferenciales del logaritmo de ingreso per cápita es testeado dentro de un marco de cambio de régimen markoviano. En contraste con los estudios existentes, este artículo define dos nuevos conceptos de convergencia del producto, donde uno permite tanto la posibilidad de que la conducta de los diferenciales de producto varíe entre regímenes estacionarios y no estacionarios (convergencia parcial), así como que cambie entre regímenes caracterizados por diferencias en el grado de persistencia (convergencia variada). Mientras las pruebas comunes de raíz unitaria univariadas y de datos de panel sugieren claramente que los diferenciales de ingreso son no estacionarios, el uso de la metodología de cambio de régimen indica que la mayoría de la muestra está caracterizada por la existencia de dos regímenes estacionarios diferentes. Además, se arguye que la comúnmente citada tasa de convergencia de dos por ciento por año está probablemente subestimada.

Keywords: *Output convergence, regime-switching, stationarity, unit root tests.*

JEL codes: *F0, F3, C2.*

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I. Introduction

The question of whether or not real per capita incomes across countries are converging has been addressed by a wide range of studies. Cross-sectional studies by Barro (1991), Barro and Sala-I-Martin (1991,1992), Baumol (1986), Sala-I-Martin (1996), Mankiw *et al.* (1992) and others offer some support for conditional convergence across large samples of countries characterized by an annual rate of convergence of about two per cent. However, a number of authors such as Quah (1996) point to convergence clubs and question the two per cent convergence rate, while Bernard and Durlauf (1995), Li and Papell (1999) and Cheung and Pascual (2004) extol the virtue of examining long-run convergence within a time-series framework. This latter group of studies, however, offer very mixed evidence in support of convergence.

In focusing specifically on convergence among less developed countries (LDCs), McCoskey (2002) suggests that convergence clubs and regional homogeneity is probably unresolved with respect to LDCs. Although there are substantial national differences in real GDP per capita that show little sign of closing, one might expect that geographic proximity and cross-national economic interdependencies will influence groups of LDCs to grow or falter as one. As noted by Dobson and Ramlogan (2002), little is known about the convergence process among LDCs and the limited range of studies that have considered LDCs have proceeded at a highly aggregated level [Khan and Kumar (1993)] or have focused on convergence within a particular country [Ferreira (2000), Nagaraj *et al.* (2000), Choi and Li (2000)].

This paper tests for the non-stationarity, or non-convergence, of output differentials. However, the key contribution of this research is to build upon existing work through an investigation based on Augmented Dickey Fuller (ADF) unit root testing within a Markov regime-switching framework. This MS-ADF approach, which is in sharp contrast to existing studies of output convergence, offers valuable new insights into the convergence debate where the time-series properties of output differentials are modelled as regime-dependent. This enables the identification and analysis of convergence and non-convergence episodes. Existing studies of output convergence tend to compute a single test statistic for testing non-stationarity across the entire study period. However, this approach can lead to a bias towards accepting the non-stationary null thereby rejecting output convergence, or give a false impression of the speed of adjustment towards long-run equilibrium, because there is no distinction between alternative regimes.

A further advantage of this technique is that for each time period, the MS-ADF methodology allows the researcher to estimate the inferred probability of the real output differential being subject to a particular (stationary or non-stationary) regime. We can, for example, consider whether the macroeconomic turbulence of the 1980s and 1990s led to a shift between regimes of convergence and non-convergence, or reflect on the relative nature of convergence during earlier decades.

The paper is organised as follows. The following section discusses recent relevant literature on output convergence. The potential contribution of this study is more clearly explained against this background. This section also outlines the methodological approach. ADF regressions are constructed within a Markov regime-switching framework. The third section describes the data and reports the results. The data are annual real GDP per capita for the Latin American economies over the study period 1900-2003. All standard unit root tests are unable to reject the null of a non-stationary real output differential. Using the new MS-ADF test, we can identify stationarity of the income differentials long-run output convergence in at least one regime for most members of the sample. Indeed, we find that over half the sample are characterised by two stationary regimes that the more familiar ADF unit root tests are unable to distinguish. In addition to this, we argue that the two per cent per annum speed of adjustment estimate reported in conventional cross-section studies is an underestimate. The final section concludes.

II. Recent Literature and Methodology

The neoclassical growth model predicts that countries will converge towards their balanced growth paths where per capita growth is inversely related to the starting level of income per capita. Early studies by Barro (1991), Barro and Sala-I-Martin (1991,1992), Baumol (1986), Sala-I-Martin (1996) and others that consider convergence across countries, US states and European regions, argue that in most instances the rate annual rate of convergence is roughly two per cent. This is confirmed by studies such as Mankiw *et al*. (1992) who investigate conditional convergence that allows for population growth and capital accumulation.

Quah (1996) questions the two per cent convergence rate and argues that convergence will take place within relatively homogenous convergence clubs. As discussed by Cheung and Pascual (2004), one can challenge the appropriateness of the cross-country regression approach to measuring output convergence. Indeed, Quah (1993) shows that a negative correlation between output growth and initial output is consistent with a stable variance in cross-country output. Bernard and Durlauf (1996) argue that the initial-output regression approach tends to reject the null hypothesis of non-convergence too often in the presence of multiple output equilibria. Furthermore, Evans (1997) points out that the cross-sectional approach may generate inconsistent convergence rate estimates, which lead to incorrect inferences. The arguments put forward in these papers leads researchers to consider the use of time-series methods to study international output convergence. Under a time-series framework, convergence requires real per capita cross-country output differentials to be stationary; that is, the levels of per capita national output are not diverging over time.

Recent studies that employ a time-series approach to international output convergence include, *inter alia*, Bernard and Durlauf (1995), Li and Papell (1999) and Cheung and Pascual (2004). Bernard and Durlauf employ multivariate techniques advocated by Phillips and Ouliaris (1988) and Johansen (1988) on log real GDP per capita data over the period 1900-1987 and find little evidence of convergence. While there is evidence of a number of common long-run factors driving OECD per real per capita outputs, they are unable to reject the null of non-convergence because several long-run processes are driving international output. Li and Papell (1999), on the other hand, explicitly examine convergence of per capita output for sixteen OECD countries against a background of structural breaks. They develop techniques which incorporate endogenously determined break points to test the unit root hypothesis in relative per capita income. The tests provide evidence of convergence for many of their sample. Their findings reveal that World War II is the major cause of the structural shifts in relative output. Cheung and Pascual (2004) investigate output convergence for the OECD countries using panel time-series techniques. They consider the possibility that low test power in existing studies is responsible for the inability to reject null hypotheses of both non-convergence and then convergence. The employment of panel data unit root and stationarity tests supports long-run convergence. However, their results also highlight some potential problems on interpreting results obtained from these procedures.

The study by Dobson and Ramlogan (2002) investigates convergence among Latin American countries over the study period 1960-90. They find evidence of unconditional beta convergence (poor countries growing faster than richer countries towards a common steady state) but not sigma convergence (distribution of income becoming more equal) across the full study period. However, by looking at sub-periods, they find that the rates of conditional convergence towards individual steady states are highest during the 1970s-mid 1980s.

In the light of the above discussion, this paper employs a time series approach to the investigation of output convergence in Latin America. In doing so, the MS-ADF approach allows for the possibility that countries may move between regimes of convergence and non-convergence. Let y_{it} be the natural logarithm of country i's real per capita output and y_t^* be the natural logarithm of benchmark real per capita output. The non-convergence null and convergence alternative hypotheses may be respectively stated as

$$\begin{aligned} H_0 &: \mu_t = \left(y_{it} - y_t^*\right) \sim \mathrm{I}(1) \\ H_1 &: \mu_t = \left(y_{it} - y_t^*\right) \sim \mathrm{I}(0) \end{aligned} \tag{1}$$

The usual test for linear adjustment towards output convergence is based assessing the unit root properties of μ_t through the OLS estimation of Augmented Dickey Fuller (ADF) regressions such as

$$\Delta\mu_t = \alpha + \rho\mu_{t-1} + \sum_{i=1}^{k} \psi_i \Delta\mu_{t-i} + \nu \tag{2}$$

where ν_t is a white noise residual and $-2 < \rho < 0$ indicates stationarity of the real output differential which is consistent with long-run output convergence. Using this approach to assessing convergence, it should be pointed out that the unit root testing of output differentials includes a constant term. Therefore, finding evidence of stationarity and mean reversion towards a non-zero constant does not imply absolute convergence towards the same levels of GDP.

This paper explores the possibility that this approach towards testing the non-stationarity of μ_t is too restrictive. Moreover, the dynamic behaviour of μ_t might be subject to regime shifts and if so, it is possible to improve on econometric approaches based on equation (2) that make no allowance for this. Indeed, this might be the reason why existing empirical studies often find against output convergence by accepting the non-stationary null. Suppose a discrete random variable S_t takes two possible values $S_t = (0,1)$ and serves as an indicator for the state of the world economy at time t. The expected component of $\Delta\mu$, conditional on the value of S_t, is given as follows:

$$E(\Delta\mu_t \mid S_t) = [(1-S_t)\alpha_0 + S_t\alpha_1] + (1-S_t)\lambda_0\mu_{t-1} + S_t\lambda_1\mu_{t-1} + (1-S_t)\sum_{i=1}^{l}\xi_i\Delta\mu_{t-i} + S_t\sum_{i=1}^{l}\tau_i\Delta\mu_{t-i} + \varepsilon_t \tag{3}$$

where $\varepsilon_t \sim i.i.d.N(0,\sigma_\varepsilon^2)$ and the unobserved indicator variable, S_t, evolves according to the first-order Markov-switching process described in Hamilton (1989):

$$\begin{aligned} P[S_t = 0 \mid S_{t-1} = 0] &= p = \Phi(\delta_0),\ P[S_t = 1 \mid S_{t-1} = 0] = 1-p \\ P[S_t = 1 \mid S_{t-1} = 1] &= q = \Phi(\delta_1),\ P[S_t = 0 \mid S_{t-1} = 1] = 1-q \end{aligned} \tag{4}$$

where p and q are the fixed transition probabilities of being in Regime 0 or 1 respectively with $0<p,q<1$, and $\phi(\ \ )$ is the cumulative normal distribution function ensuring that the transition probabilities lie in the open interval (0,1). Stationarity in both regimes is confirmed if $-2 < \lambda_0, \lambda_1 < 0$. If $-1 < \lambda_0, \lambda_1 < 0$, the half-life associated with a deviation from long-run equilibrium may be computed as $HL_0 = (\ln 0.5)/(1+\lambda_0)$ and $HL_1 = (\ln 0.5)/(1+\lambda_1)$ for Regimes 0 and 1 respectively. If $\lambda_0 \neq \lambda_1$, we may define the concept of *varied output convergence* because long-run output convergence is confirmed across the entire study period, but the autoregressive coefficients and speeds of adjustment towards long-run equilibrium are different. On the other hand, we may only be able to confirm that either λ_0 or λ_1 is significantly different from zero. In this case, we may define the concept of *partial output convergence* because the real output differential is switching between regimes of stationarity and non-stationarity.

The unit root tests employed in this paper exclude deterministic trends. The reason for the exclusion is that a trend-stationary differential will imply reversion to trend of the differential, but GDP per capita levels may still be drifting apart. Therefore, a trend stationary differential may be inconsistent with the convergence of GDP per capita levels. Given that both the ADF and MS-ADF unit root tests on the differentials exclude a deterministic trend, a differential based on two trend-stationary series will only be stationary if the two series have the same deterministic trend. Otherwise, running the ADF and MS-ADF unit root tests (trend excluded) will lead to the acceptance of the non-stationary null. With regards to the MS-ADF results, rejection of the non-stationary null might possibly include a regime within the study period where two trend-stationary GDP per capita levels may have the same deterministic trend giving rise to a stationary differential.

Chumacero (2006) and others indicate that the standard ADF tests of convergence not only have non-standard asymptotic properties, but also lack power. Indeed, Kanas and Genius use simulations, and point out that when the autoregressive coefficient for the stationary regime is close to zero, the standard ADF test fails to distinguish a "sometimes" integrated model from an I(1) process in majority of cases. While this confirms the lack of power of the standard ADF test, Kanas and Genius find that the MS-ADF test will always reject the null.

Hansen (2000) employs a threshold model, which is a special case of a regime-dependent model, to address output convergence. While Hansen's model can be rationalized as a motivation of Quah's club convergence, the primary purpose of the paper is to develop an asymptotic distribution of the least squares estimate of the threshold coefficient. Here the change in real output from base period is regressed on the level of output in the base period along with schooling, investment and growth in the labour force. Using cross-section data, estimation of the threshold model with different threshold variables offers reasonable evidence of a two-regime specification. While the MS-ADF approach also endogenously identifies each regime, this paper differs from Hansen in a number of key ways. First, the focus here is also on convergence, but in the context of unit root testing. Second, this study formally analyses the regime-specific coefficient estimates that throw light on differential convergence speeds.

III. Data and Estimation

This study employs annual data for real GDP per capita for Argentina, Brazil, Chile, Colombia, Mexico, Peru, Uruguay and Venezuela over the study period 1900-2003. In common with Bernard and Durlauf (1995), Li and Papell (1999) and Cheung and Pascual (2004), this study employs data from the Maddison database [Maddison (2006)]. The data are adjusted to exclude the impact of boundary changes where GDP per capita is calculated by dividing aggregate GDP by the mid-year population level. Benchmark real GDP per capita is computed as the average of these eight countries. Figure 1 plots the output differentials as indicated in equation (1). Earlier unit root testing confirmed non-stationarity of each of the income levels. It is clear that the series are characterised by high degrees of persistence.

The first stage of the empirical investigation is to test the stationarity of real GDP per capita differentials using the familiar univariate ADF unit root test. Pre-testing of the data indicated that GDP per capita levels are trend stationary in a number of cases.[1] Table 1 reports the findings for the full sample of output differentials defined for eight countries. These initial results do not provide convincing evidence of long-run convergence. At the 10% significance level, we are unable to reject the null of non-convergence using the ADF test in all eight cases. Further testing involves the KPSS test which sets the null hypothesis as stationarity. In all cases, the stationary null is strongly rejected in favour of the non-stationary alternative at the 1% significance level.

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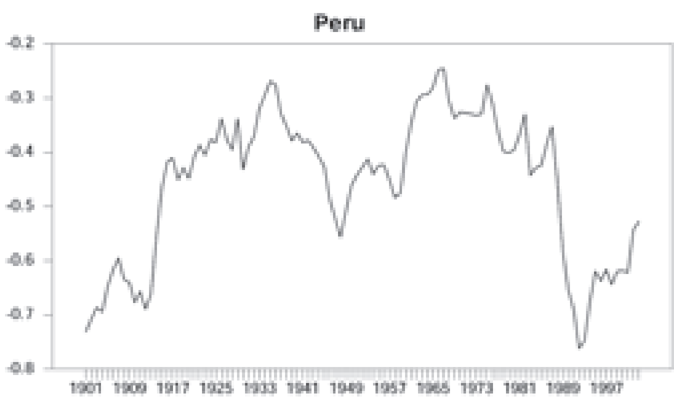
1 This is is in line with studies such as Chumacero and Fuentes (2006) who use two different data sets for the periods 1810-1995 and 1960-2000 and find that both per capita and per worker GDP in Chile can be better characterized as trend-stationary random variables.

FIGURE 1
REAL GDP PER CAPITA DIFFERENTIALS


Colombia
-0.16
-0.24
-0.32
-0.40
-0.48
-0.56
-0.64
1901 1909 1917 1925 1933 1941 1949 1957 1965 1973 1981 1989 1997


Mexico
0.1
-0.0
-0.1
-0.2
-0.3
-0.4
-0.5
1901 1909 1917 1925 1933 1941 1949 1957 1965 1973 1981 1989 1997


Peru
-0.2
-0.3
-0.4
-0.5
-0.6
-0.7
-0.8
1901 1909 1917 1925 1933 1941 1949 1957 1965 1973 1981 1989 1997

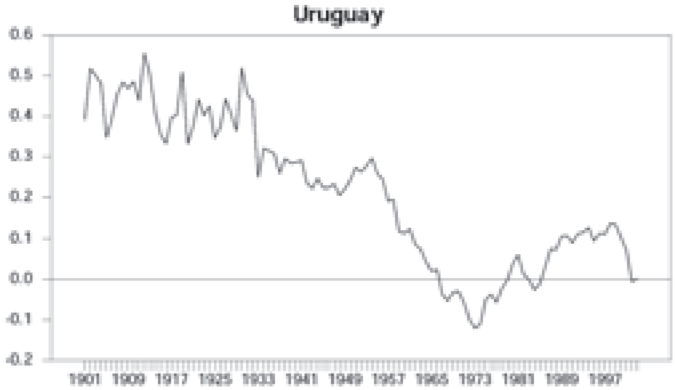


TABLE 1
ADF UNIT ROOT TESTING

	ADF	KPSS
Argentina	–1.482	1.202
Brazil	0.012	1.120
Chile	0.417	1.138
Colombia	–0.133	1.130
Mexico	0.202	1.073
Peru	–2.155	1.168
Uruguay	–1.654	1.202
Venezuela	–2.007	0.959

Notes for Table 1. Lag length determined by the SIC. All tests include a constant, but exclude a time trend. The 10% critical value for the ADF test is -2.900. The KPSS test features the null of stationarity. The 1% critical value for the KPSS test is 0.739.

A further issue here may be that the univariate unit root tests reported in Table 1 are subject to low test power thereby leading the researcher to find against stationarity. Table 2 reports the findings from panel data unit root testing based on a panel of Latin American output differentials. Both the Levin, Lin and Chu (2002) and Im, Pesaran and Shin (2003) tests are unable to reject their respective null hypotheses of joint non-stationarity. In addition to these results, the Hadri (2000) test indicates that one can reject the null of joint-stationarity.

We now consider the possibility that for the entire sample, the absence of output convergence, or the inability to reject the null of a non-stationary income differential, may be attributable to hitherto unacknowledged regime switches with respect to the time series properties of the data. Table 3 reports the MS-ADF unit root tests in detail. Having started with a maximum of eight lags, the inclusion of one lagged value of $\Delta\mu$ in equation (3) was found to be acceptable. With the exception of Brazil and Chile, we find that λ_0 and/or λ_1 are/is both negative and significant at the 5% significance level or better. Across the sample, we are therefore able to identify stationarity of the real per capita output differentials in at least one of the two regimes. In addition to this, the rejection of the null $\sigma_0 = \sigma_1$ in the cases of Argentina, Chile, Mexico, Uruguay and Venezuela is consistent with the two regimes being characterised by different volatilities in growth differentials.

Chumacero (2006) and others also highlight that in many cases, even if a unit root were not present, it might take a long time for the effects of a shock to dissipate. This is underlined by the often-cited 2% rate of convergence. The findings in this paper suggest a faster rate of convergence may in fact be applicable. The cases where stationarity is present in one regime only involve Mexico and Venezuela. This finding of partial output convergence may be compared to the unit root test results reported in Table 1 that dismissed output convergence altogether. The new results reported in Table 3 suggest that when output convergence is present, the half-life of a deviation from long-run equilibrium is 14.377 and 20.132 years for Mexico and Venezuela respectively. For both these countries, the output differential is also subject to regimes of non-stationarity. Indeed, it is noticeable that with $\lambda_1 > 0$ the Venezuelan output

TABLE 2

PANEL TESTS

	Statistic
Levin, Lin and Chu (2002)	0.860
Im, Pesaran and Shin (2003)	2.075
Hadri (2000)	17.099***

Notes for Table 2. Levin, Lin and Chu (2002) and Im, Pesaran and Shin (2003) test the null hypothesis of joint non-stationarity. Levin, Lin and Chu assume a common unit root process whereas Im, Pesaran and Shin assume individual unit root processes. Hadri (2000) assumes a common unit process and tests the null of joint stationarity. *** denotes rejection of the null at the 1% significance level. These tests are asymptotically normal with a 5% critical value of -1.64 (Levin, Lin and Chu (2002) and Im, Pesaran and Shin (2003)) and 1.64 (Hadri (2000)).

TABLE 3
MS–ADF UNIT ROOT TESTING

	Argentina	Brazil	Chile	Colombia	Mexico	Peru	Uruguay	Venezuela
α_0	-0.030^a	0.005	0.023^a	-0.010^a	0.018^a	-0.064^a	0.337^a	0.018^b
α_1	−0.000	0.002	−0.015	-0.349^a	-0.019^a	-0.252^a	0.001	-0.045^a
λ_0	-0.054^a	−0.008	−0.028	-0.022^a	0.012	-0.177^a	-0.799^a	-0.034^b
λ_1	-0.021^c	−0.001	−0.056	-0.890^a	-0.047^c	-0.384^a	-0.046^b	0.060^a
σ_0	0.000^b	0.001^b	0.001^a	0.001^a	0.000^a	0.001^a	0.004^a	0.004^a
σ_1	0.002^a	0.001^a	0.007^a	0.001	0.003^a	0.001^a	0.001^a	0.000a
δ_0	0.427	0.146	1.503^a	3.831^a	3.248^a	3.147^a	3.502^a	1.942^a
δ_1	2.255^a	1.560^a	1.176^b	1.648^c	3.230^a	1.778^a	33.244^a	1.141^b
ξ_0	0.269^a	-0.989^a	0.058	0.236^b	0.087	0.256^a	0.151	0.237^b
τ_1	−0.051	0.482^a	−0.121	0.325^b	−0.087	0.365^b	0.114	0.500^a
LL	194.445	187.629	148.795	214.153	185.924	195.941	186.245	155.020
Null[1]	0.000	0.880	0.005	0.562	0.000	0.434	0.001	0.000
Null[2]	0.004	0.567	0.661	0.000	0.070	0.000	0.000	0.000
HL_0	12.434	N/A	N/A	31.296	N/A	3.557	0.432	20.132
HL_1	33.152	N/A	N/A	0.314	14.377	1.430	14.688	N/A

Notes for Table 2. Estimates are for the regime–switching model described by equations (3) and (4) or (3) and (5). The superscripts a, b and c denote rejection of the zero null at the 1, 5 and 10% significance levels respectively. LL is the log likelihood value. Null[1] refers to the null hypothesis $\sigma_0 = \sigma_1$, Null[2] refers to the null hypothesis $\lambda_0 = \lambda_1$, HL denotes half life (years) and p-values are reported for the hypothesis tests.

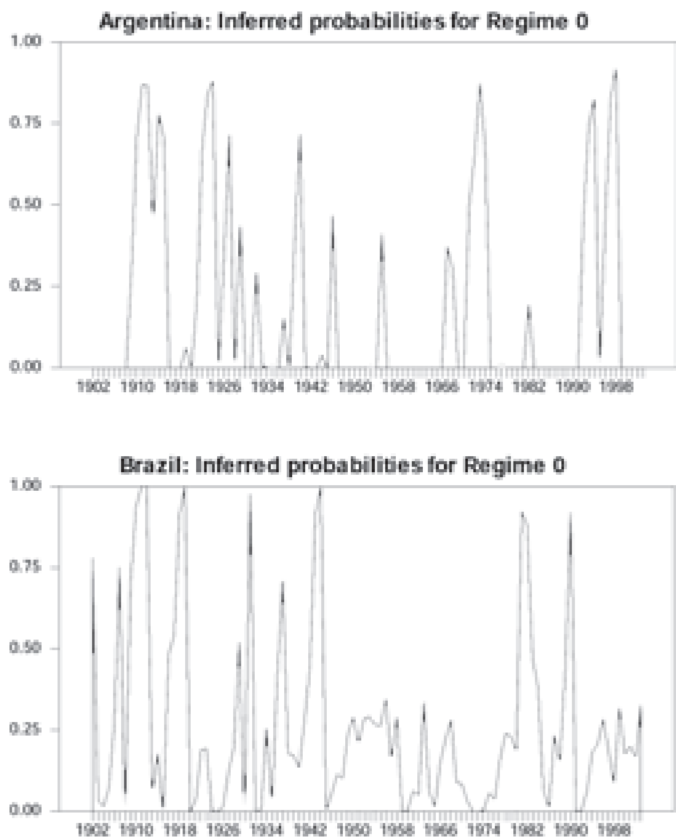
differential is subject to regime switching between stationary and explosive behaviour with divergence from the Latin American sample.

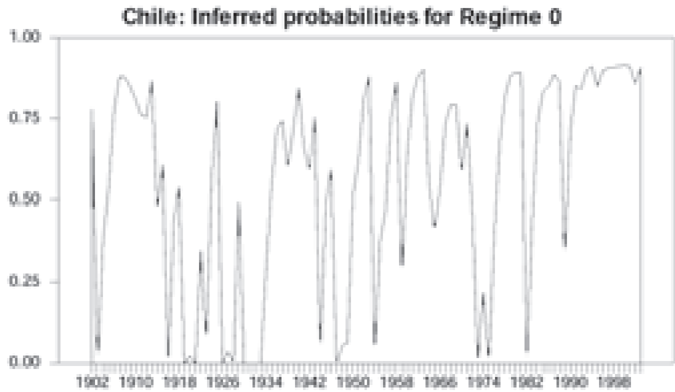
With regard to the dynamic behaviour of the income differential, the parameters of the autoregression are governed by the regime that the process is in at any given date. If one considers the study period as a whole, then it can be argued that cases of partial convergence might be dominated by the unit root regime in the sense that non-convergence will prevail. Equally, switching into stationary regimes will mitigate divergence tendencies. However, later examination of the inferred probabilities indicates that the stationary regimes can in fact last many years, or even decades, thereby suggesting that stationarity can potentially dominate the unit root in the stochastic process for sub-samples of time.

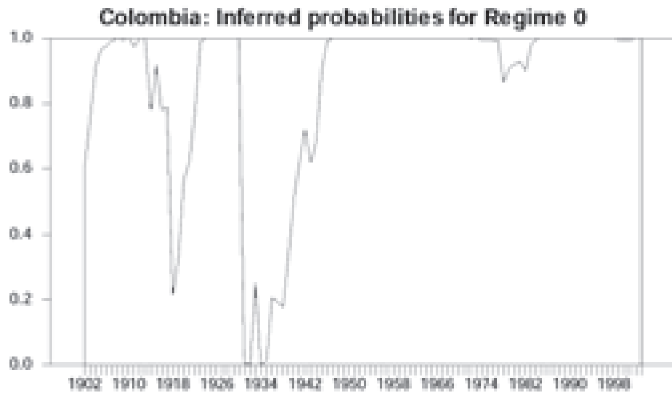
In the cases of Argentina, Colombia, Peru and Uruguay, the real output differential is characterised by two stationary regimes. Given these two regimes feature output differentials with differing dynamic properties, the respective countries are characterised by varied output convergence. Long-run output convergence appears to hold throughout the study period, though there are marked differences in the half-lives associated with each of these regimes. Colombia, for example, has half-lives of 31.296 and 0.314 years for Regime 0 and Regime 1 respectively. More generally, rejection of the null $\lambda_0 = \lambda_1$ confirms contrasting speeds of adjustment across these regimes. With respect to each of these cases, λ_0 and λ_1 are most probably sufficiently far apart to lead the researcher to accept the null of non-stationarity in the earlier unit root reported in Table 1. These findings can be seen in the context of Evans (1997) and others who question the validity of the two per cent per annum rate of convergence. Such a convergence rate implies a half-life of 34.3 years. With the exception of the Argentinean differential in Regime 1 and Colombian differential in Regime 0, this is well in excess of the estimates reported here. Indeed, Evans (1997) argues that the convergence rates computed for a sample of 48 countries are more realistically 5.89% per annum. This implies a half-life of 11.418 years which is much comparable to some of the half-lives reported in Table 3.

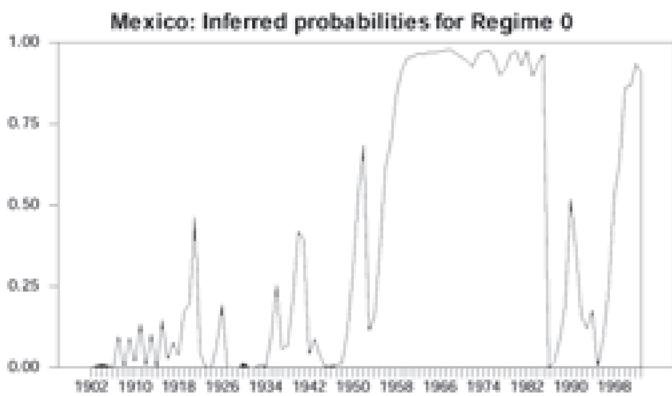
For each output differential, Figure 2 plots the inferred probabilities of being in Regime 0 during each year of the study period. The characteristic of this regime can vary from country to country. With regard to the cases of partial output convergence, Table 2 indicates this is the regime characterised by stationarity (non-stationarity) of the output differential in the case of Venezuela (Mexico). In the remaining cases of varied output convergence with two sta-

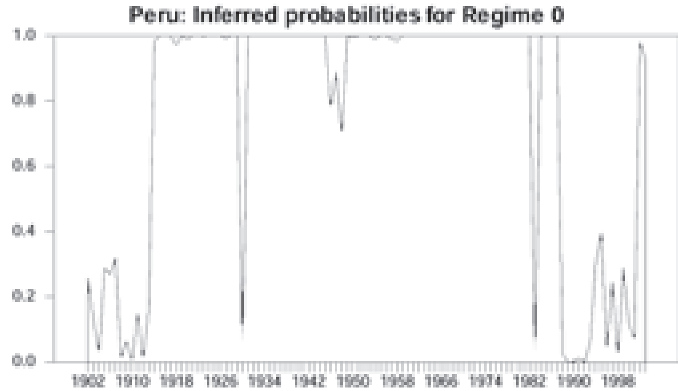
FIGURE 2
INFERRED PROBABILITIES



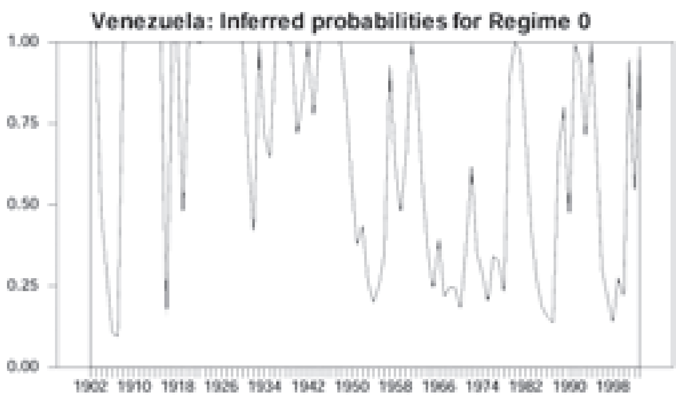

Chile: Inferred probabilities for Regime 0
1.00
0.75
0.50
0.25
0.00
1902 1910 1918 1926 1934 1942 1950 1958 1966 1974 1982 1990 1998


Colombia: Inferred probabilities for Regime 0
1.0
0.8
0.6
0.4
0.2
0.0
1902 1910 1918 1926 1934 1942 1950 1958 1966 1974 1982 1990 1998


Mexico: Inferred probabilities for Regime 0
1.00
0.75
0.50
0.25
0.00
1902 1910 1918 1926 1934 1942 1950 1958 1966 1974 1982 1990 1998


Peru: Inferred probabilities for Regime 0
1.0
0.8
0.6
0.4
0.2
0.0
1902 1910 1918 1926 1934 1942 1950 1958 1966 1974 1982 1990 1998


Uruguay: Inferred probabilities for Regime 0
1.00
0.75
0.50
0.25
0.00
1902 1910 1918 1926 1934 1942 1950 1958 1966 1974 1982 1990 1998


Venezuela: Inferred probabilities for Regime 0
1.00
0.75
0.50
0.25
0.00
1902 1910 1918 1926 1934 1942 1950 1958 1966 1974 1982 1990 1998

tionary regimes, Regime 0 is characterised by a longer half life of deviations from long-run equilibrium and therefore, a slower rate of convergence in the cases of Colombia and Peru while a faster speed of adjustment is present in the cases of Argentina and Uruguay. Figure 2 indicates a heterogeneous range of experiences. For most countries characterised by varied or partial convergence, much of the recent decades have been characterised by a slower speed of adjustment towards long-run equilibrium or non-convergence. This is punctuated by episodes of much more rapid speeds of adjustment towards long-run equilibrium. In the case of Venezuela which is characterised by partial convergence, Regime 1 is characterised by explosive behaviour in the sense of increasing output divergence. A consideration here is that the oil price shocks in recent years have seen the Venezuelan economy benefit from its status an oil exporter. This is in contrast to other sample members. Finally, Brazil and Chile are characterised by two non-stationary regimes. For these countries, there is no evidence of long-run convergence.

IV. Conclusion

This study has addressed a key issue concerning the mixed time-series evidence concerning output convergence. This study employs a long span of time-series data. However, a novel approach is that output convergence is modelled as a regime switching phenomenon where the Latin American economies switch between stationary and non-stationary output differentials, or between two different regimes of stationary differentials. It is only through the application of the unit root testing with a regime-switching framework that we are able to appreciate the presence of heterogeneity in output dynamics across time. For most countries, the evidence indicates that output convergence has in fact been present in some form across the entire sample period. Such an approach leads us to conclude that existing tests of output convergence do not adequately deal with regime changes and their reliance on a single test statistic leads researchers to accept the null hypothesis of non-convergence. Further evidence indicates that the often-cited two per cent rate of convergence identified in cross-sectional studies is an underestimate. Indeed, the convergence rate is likely to be much faster than this even during regimes of relatively sluggish convergence.

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