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[Continued inside the back cover]

ENDOGENOUS GROWTH AND EXOGENOUS SHOCKS IN LATIN AMERICA DURING THE TWENTIETH CENTURY

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Abstract

Using a new database for the whole 1900–2000 period, this paper estimates the relative contribution of endogenous and exogenous factors in GDP and productivity growth in each of the six larger Latin American economies with multivariate annual models, and complements these with a single aggregate model using panel data by decade to test for convergence within the region and with the US. Our method is innovative as it includes external economic shocks as well as endogenous growth variables. The main findings are: (*i*) that investment contributed most to growth during the middle of the century when the region was relatively closed to the world economy and state was proactive; (*ii*) that the six main economies did converge considerably over the century due to improvements in resource allocation, advances in health and education and increased investment effort; (*iii*) that these improvements were not, however, enough to produce convergence between Latin America and US; and (*iv*) that terms of trade volatility, trade and interest rate shocks were major obstacle to both sustained economic growth and catching up.

JEL keywords: Economic History, Economic Growth, Latin America
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I. Introduction•

The salient feature of Latin American economic performance during the twentieth century is the lack of productivity convergence on the industrialised countries. To be specific, while life expectancy and literacy in Latin America converged on US levels, GDP per worker at the end of the last century remained roughly at one-seventh of the US level.[1] Our aim in this paper is to explain the persistence of this gap by econometric testing of growth and convergence models on consistent and comparable estimates of GDP and workforce for the whole century, presented in the new OxLAD database.[2] Although OxLAD contains data on the whole region we restrict this analysis to 1900–2000 and to the larger economies in the continent (Argentina, Brazil, Chile, Colombia, Mexico and Venezuela) which together account for about three-quarters of the region's GDP and population.

There are several long-run descriptive 'growth accounting' exercises for Latin America, Elias (1992) and Hofman (2000) being the most comprehensive, but these do not test growth models formally. Those studies that do are surveyed in Mejía Reyes (2003), but all start from 1950 at best (and often later) and thus are dominated by the crises of the last quarter-century and do not capture the full industrialisation process, nor do they test for structural breaks. In fact, as Astorga, Bergés and FitzGerald (2003*b*) show, there is a sinusoidal pattern in the Latin American growth (i.e. the population-weighted average of per capita GDP of the six countries) with inflexion points around 1939 and 1980. In this paper we therefore employ a consistent testing procedure across countries that allow us to examine the synchronicity and nature of such growth discontinuities and the extent to which individual growth performances are determined by exposure to common shocks.

We are interested at the relative contribution of exogenous and endogenous factors to the growth process. The former can be of external origin – such as sudden changes in

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[1] See Astorga, Bergés & FitzGerald, 2004. Prados de la Escosura (2004) expanded the comparison between Latin America and the developed world by including other OECD countries and found similar results.

[2] The Oxford Latin American Economic History Database http://oxlad.qeh.ox.ac.uk/. Unless otherwise indicated the data sources are described in OxLAD. We use E-Views for all the econometric analysis.

commodity prices or international interest rates – or of internal origin such as natural resource discoveries or coups d'état.[3] The latter are those factors under the control of policymakers and economic agents, and whose current values are often determined by past values ('path dependence'). This is not just an academic debate, because the relative importance of these factors in explaining the 'Latin American economic condition' is a focus of political debate throughout the region and the basis of contested development strategies.

We adopt two different modelling specifications to analyse economic growth. Section 2 of the paper measures the contribution of the main factors accounting for GDP growth by estimating multivariate annual models – which adopt the error correction specification for each of the countries in our sample. Long-run models of the process of economic growth and convergence are a familiar part of the standard literature that does not need repetition here.[4] In addition to the accumulation of capital and labour, we allow for other factors influencing growth that are not the focus of attention of the standard growth model. The first is the structural transformation in the economy: as growth proceeds, the factors of production are attracted to high productivity sectors – typically manufacturing – increasing overall efficiency.[5] Second, gains in economic efficiency and growth potential are also expected from institutional transformations improving the provision of public goods and supporting private investment. The size of the public sector is thus seen as a key variable with a potentially positive (or negative if it is inefficient or chronically in deficit) effect on growth. Third, in this paper we also attempt to capture exogenous economic shocks to growth, particularly the effect of world trade fluctuations on the one hand and international financial conditions on the other. This is not common in the growth literature, but is clearly essential for an understanding of long-run economic growth in Latin America.

Section 3 of the paper estimates the degree of convergence both as a process of homogenisation among the Latin American countries and catching up with the US through a panel data exercise. The standard neoclassical model predicts that countries with similar savings rates and population growth and with access to the same technology will con-

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[3] In this work we are assuming political events as exogenous to the economic process in the sense that there are taken as given in the model's specification, even though we are aware that economic events (such as the Great Depression of the Debt Crisis) can lead to major political change.

[4] Among the extensive literature on the topic see Abramovitz (1986), Baumol (1986), Baumol, Nelson, and Wolff (1993), Barro and Sala i Martin (1995). And, more recently, Rodrik (2001) stressing the role of institutions.

[5] This source of convergence is absent in the one-sector neoclassical model, which simply assumes that the initial resource allocation is efficient. However, it has been the focus of attention of development economists since Lewis model (1954) at least.

verge to similar levels of income and capital per-worker at a steady state – where savings just compensate for capital depreciation and labour force growth. The assumption of diminishing returns to capital is key to this prediction.[6] However, the realisation of the potential for catching up is far from guaranteed. There are a series of factors such as natural resource endowment, barriers to the diffusion of technology, human capital, political stability and social and institutional capability that condition the pace at which potential can be realised.

Moreover, endogenous growth models have added new elements to the analysis of economic convergence and new reasons to expect divergence.[7] The lack of absolute convergence (in our case, on the US) can then be explained in a number of ways. For instance, according to the neoclassical growth model if countries differ in one or more of the crucial parameters each of them will settle into a different steady state; or if technology does not flow smoothly, developing economies will find it difficult to catch up with the leaders. In this case, however, countries may still exhibit a process of conditional convergence after controlling for possible differences in parameters across countries. In this paper, therefore, we employ a battery of variables to account for these technological and institutional factors on the one hand, along with the international economic variables to test for the effect of exogenous shocks on convergence on the other.

Section 4 concludes with a general interpretation of the results of the two econometric exercises in terms of the causes of, and obstacles to, economic growth in Latin America during the twentieth century.

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[6] This assumption is tested empirically for the same data in Astorga, Bergés and Fitzgerald (2003*b*) and shows that returns to scale are broadly constant for our six economies.

[7] The common feature in this class of models is the relaxation of the assumption pf diminishing returns, which in turn undermines the 'catch up' hypothesis – see Romer (1986), Grossman and Helpman (1994), and Mankiw, Romer, and Weil (1992).

2. Time Series Modelling of the Six Major Economies

Our first step is to analyse individual time series in order to identify major discontinuities in the growth process, both in levels and per-head terms. The task of identifying structural breaks during the last century will inform the specification of multivariate annual models later in the section.

Structural breaks

We test for structural breaks in the series of GDP and GDP per head, using the Chow test applied to autoregressive models to assess parameter stability. One approach, following Zivot and Andrews (1992), uses the rejection of the unit root hypothesis in aggregate macroeconomic series as evidence of structural breaks, with the break identified by an interruption in the slope or the intercept. An alternative procedure is to focus on the analysis of parameter stability in the differentiated series (Hansen, 2001). In this paper we take the latter route in order to identify the presence of discontinuities in the series. None the less, our findings on the timing of breaks are consistent with the dates reported in country studies that adopt the first approach, such as Noriega and Ramirez (1999) for Mexico or Utrera (2001) and Sanz (2004) for Argentina.

Our estimates of structural breaks are summarised in Table 1 below (the estimation details are in Appendix I). In all six countries the series of GDP, GDP per worker and GDP per capita – after applying a logarithmic transformation – were found to be integrated of order one; and all three series tend to have the same timing of breaks of the GDP series. Only in the case of Colombia (1980–82) and Mexico (1995) did the tests performed on the GDP per capita series fail to confirm the evidence for breaks found in the other two series.

A number of the structural breaks are the result of external shocks affecting the six economies simultaneously: in the early 1930s, associated with the Great Depression; and again in the early 1980s associated the shift in US monetary policy and the debt crisis. There are other instances where a shock common to all countries resulted in country-specific breaks: a major discontinuity around 1914 in Argentina caused by the impact of WWI and economic instability in Chile in the early 1920s coinciding with post-war world recession. This seems to be due to differences in commodity exposure.[8] However, while external events were the main source of macroeconomic fluctuation,

[8] Argentina's close links with the UK for exports and investment meant that WWI has stronger consequences than in those economies with closer ties with the US; whereas in Chile the impact of the worldwide disruptions in the early 1920s was exacerbated by the country's dependence on the export of nitrates which at the time were being replaced by chemical fertilizers.

affecting all countries more or less simultaneously, during the first half of the century; as these economies became more diversified (and thus relatively less exposed to external fluctuations) in the second half of the century, the structural breaks appear to have become less synchronised.

Table 1: Summary of Structural Breaks

	period	GDP	GDP per worker	GDP per capita
Argentina	(1900-2000)	1914 * ; 1930 1976 ; 1992	1914 * ; 1930 1976 ; 1992	1914 * ; 1930 1976 ; 1992
Brazil	(1900-2000)	1929-30 * 1963 ; 1981	1929-30 * 1963 ; 1981	1929-30 * 1963 ; 1981
Mexico	(1900-2000)	1910s ; 1930-31 (rev) 1981-82 ; 1995	1910s ; 1930-31 (rev) 1981-82 ; 1995	1910s ; 1930-31 (rev) 1981-81
Chile	(1909-2000)	1920-22 * ; 1933 1972 ; 1982 (rev)	1920-22 * ; 1933 1972 ; na	1920-22 * ; 1933 1972 ; na
Colombia	(1905-2000)	1929-30 1980-82	1929-30 1980-82	1929-30 no rejection
Venezuela	(1900-2000)	1923-25 1930 * ; 1978	1923-25 1930 * ; 1978	1923-25 1930 * ; 1978

rev = tests performed with series in reverse order ; na = not available
(*) Chow test failed but there is strong evidence of parameter instability

There are a number of shocks where the main cause appears to be internal, and not always directly related to economic factors. These include the Mexican revolution in the 1910s, Venezuela's transition from a coffee economy to a booming oil economy (reflected in the structural break around 1924), and Brazil's recession in the early 1960s. Also belonging to this group is the discontinuity in the Chilean economy around 1973 associated with the overthrow of Allende and the political oppression and property reform that followed.

The last decade of the last century has also seen non-synchronised breaks that are internal in origin. These include convertibility in Argentina since 1992 (positive effect), the joining of NAFTA in Mexico in 1995 (positive), and continued political instability and institutional experiments in Venezuela in the 1990s. A further aspect to highlight is that over the last quarter century, there are differences in the timing of the slowdown from the strong economic growth experienced by all six economies during the 1960s and early 1970s. We found evidence of structural breaks in Chile around 1973 and 1982 and in Argentina around 1976. Venezuela experienced a significant downturn starting in 1978. Meanwhile, Colombia, Brazil and Mexico had a structural break in the early 1980s.

The error correction model (ECM)

The use of the error correction specification allows us to distinguish between short run and long run effects in the growth process; and by estimating models that span time periods where structural breaks were identified we can assess variations in the relative importance of the endogenous and exogenous factors. Moreover, the feedback coefficient associated with the ECM has an important economic interpretation: defining the speed of adjustment to disequilibrium dynamics, and thus in our case the ability of economies to adjust speedily to shocks.[9] The standard model can be written:

(1) $?Y_t = b_0 + a[Yt–1 – KX_{t–1}] + b_i?X_t + e_t$

(2) $Y^* = KX^*$

where in (1) Y_t is the dependent variable, X_t a set of explanatory variables, and ? the first difference operator; and (2) is the long-run equilibrium relationship.

Our long-run equation is a standard supply function where the factors of production are *gross fixed capital formation*, the *economically active population (EAP)* to account for the labour force, and a trend variable reflecting changes in the *productive structure* of the economies.[10] Labour is adjusted by improvements in literacy to reflect qualitative changes due to increased human capital. *K* is then a vector of coefficients linking GDP (in levels) to its main economic drivers. A prerequisite for the validity of the ECM approach in the non-stationary case is that the series under analysis are co-integrated. In our case the Johansen's test failed to reject the null hypothesis of 'no co-integration' in all countries. The presence of co-integration is also supported by ADF testing, which shows that the residuals of the long-term equation are stationary.

The ECM equation (1) includes two main effects. First, the *feedback effect (a)* refers to the error to which adjustment is made in the model. The error-correction term (*a*) should be negative, for deviations of output from the long run determinants results in a move back towards equilibrium, and its size ($–1 < a < 0$) measures the speed of this adjustment. Second, the *short-run impact coefficients* (b_i) measure the effect of contemporaneous or lagged changes in the explanatory variables on current changes in output.

[9] See Banerjee, Galbraith and Hendry (1993, chap 2).

[10] We use the perpetual inventory method to calculate the series for capital stock and the EAP series prior to 1960 are based on interpolation between censuses – see Astorga, Bergés and FitzGerald (2003*b*). The structural change variable is constructed as the inverse of the contribution of agriculture to total GDP.

Our exogenous variables are: the growth rate of net barter terms of trade and world demand,[11] together with the US real external interest rate (in levels) to account for the cost of external borrowing. Our endogenous factors are: the share of government spending on GDP (usually lagged one period) and lagged values of the rate of growth of GDP, the economically active population, and net investment. Dummy variables are introduced in the long run equation to account for the structural breaks, in the form of a step change around the time of the break. We also include dummies for major policy regime shifts such as the 1973 military coup in Chile and the 1989 emergency economic measures in Venezuela. In alternative specifications we also tested for the contribution of trade openness (the share of exports on GDP) but it was not statistically significant. This might reflect the limitations of this measure of trade policy, or that openness is an extended process inadequately captured in annual models. In addition, due to frequency limitations, we exclude variables that capture institutional and structural change. However, these factors, together with trade openness, are included in the panel data exercise in the following section.

We estimate the ECM regressions using a two-stage procedure. First, we estimate the long-term equation; then the residuals from the long-term regressions are incorporated in the dynamic models (Holden and Perman, 1994). We run ECM regressions with their corresponding long-term components for each country over the whole sample – denoted 'all' – as well as for three sub-periods defined by the structural breaks already estimated: (i) the early period of last century ('early'), usually covering from the start of the century up to WWII; (ii) the middle period ('middle'), roughly from the mid 1940s up to the mid 1970s; and (iii) the late period ('late'), in most cases covering those years between the structural break in the mid 1970s and early 1980s to the end of the century. When running the regressions over sub-periods, we use the series of residuals that result from the estimation over the whole sample. In this way we avoid undesirable volatility that could be caused by abnormal values at the beginning and end of the sub-periods.

Long-term equations and the contribution of factors of production

The results of the long-run regressions in for the large economies (Argentina, Brazil and Mexico) are summarised in Table 2A; while Table 2B reports on the medium-size economies (Chile, Colombia and Venezuela), which are also more open in the sense of

[11] The variable accounting for world demand is obtained by weighting import volume annual series of the countries' main trading partners (i.e., the US, the UK, Germany, France, Japan and other Latin American countries) with export shares by destinations (also with an annual frequency).

Table 2A: Long-term Regressions

	Argentina				Brazil				Mexico			
Dep. Var: **GDP in logs**	all	early	middle	late	all	early	middle	late	all	early	middle	late
Period	1900-2000	00-45	46-75	76-00	1900-2000	00-34	35-61	62-00	1900-2000	00-38	38-75	76-00
Long-term effect												
(variables in levels, logs)												
Constant	**-1.87**	**-2.17**	**-6.06**	1.13	**-4.82**	**-16.14**	4.99	**18.59**	**-1.69**	2.03	**-20.23**	-10.54
Capital (lagged)	**0.31**	**-0.21**	0.04	0.20	**0.46**	**-0.16**	**0.28**	**0.75**	**0.26**	-0.37	**-0.51**	**1.37**
Labour force (lagged)	**0.55**	**1.11**	**-1.17**	**4.39**	**0.60**	-0.17	**1.35**	**1.66**	**0.86**	**1.61**	**0.47**	-2.61
Structural change	**0.05**	**0.06**	**0.32**	-0.39	0.05	**0.34**	-0.13	**-0.38**	**0.02**	**-0.03**	**0.37**	**0.35**
Struc. Break 1	**-0.16**	**-0.24**	-0.06			**-0.11**			-0.05	-0.03		
Struc. Break 2		**-0.13**							**-0.13**	**-0.22**		
Struc. Break 3	-0.08			0.01	**-0.27**			-0.05	**-0.31**			**-0.20**
Struc. Break 4	0.02			**0.18**	**-0.22**			**-0.31**	**-0.14**			**-0.07**
Adjusted R2	0.992	0.993	0.982	0.932	0.998	0.991	0.997	0.984	0.998	0.943	0.999	0.952
S.E.	0.077	0.035	0.043	0.041	0.069	0.032	0.024	0.075	0.061	0.035	0.019	0.047
Openness (X$/GDP$)	15	21	11	8	14	24	11	8	12	11	7	17

Coefficients in **bold** are statistically significant at the 5% level.

Table 2B: Long-term Regressions

	Chile				Colombia				Venezuela			
Dep. Var: **GDP in logs**	all	early	middle	late	all	early	middle	late	all	early	middle	late
Period	1909-2000	09-45	38-71	71-00	1925-1998	25-48	48-75	75-98	1920-2000	20-45	46-77	78-00
Long-term effect												
(variables in levels, logs)												
Constant	**-14.46**	-8.58	1.54	**7.63**	**-1.41**	-1.79	**-1.99**	0.35	**-0.75**	-0.14	0.98	**14.67**
Capital (lagged)	**0.38**	**-1.38**	**1.33**	**0.53**	**0.20**	0.13	**0.37**	0.09	**0.76**	**0.55**	**0.34**	**-1.38**
Labour force (lagged)	0.17	2.24	**-0.60**	2.00	**0.56**	1.04	**0.86**	**1.14**	0.24	**-3.29**	**1.46**	2.06
Structural change	**0.21**	**0.14**	-0.01	-0.22	**0.06**	0.01	0.01	-0.02	0.00	**0.36**	-0.08	-0.09
Struc. Break 1	**-0.13**	**-0.32**				-0.01			**0.44**	**0.24**		
Struc. Break 2					**-0.14**			**-0.05**	**-0.26**	**-0.40**		
Struc. Break 3	**-0.13**			**-0.18**					**-0.43**			
Struc. Break 4				**-0.17**								0.13
Adjusted R2	0.989	0.889	0.993	0.976	0.998	0.981	0.998	0.995	0.995	0.973	0.997	0.903
S.E.	0.098	0.104	0.027	0.059	0.038	0.037	0.017	0.020	0.088	0.082	0.033	0.039
Openness (X$/GDP$)	22	25	11	22	13	11	10	13	28	27	29	25

Coefficients in **bold** are statistically significant at the 5% level.

having larger ratios of exports to GDP. Since all variables are in natural logs, the coefficients can be interpreted as elasticities of output with respect to the growth factors. The step dummies accounting for structural breaks can be interpreted as follows: for instance 'Struc.Break 4' for Brazil corresponds to the introduction of the Real Plan in 1994, and has a negative and significant coefficient, suggesting that *caeteris paribus* the three main variables have contributed less to growth (that is, factor productivity was lower) in 1994–2000 than for the century as a whole.[12]

[12] The step dummies for Brazil begin in 1930, 1963, 1984 and 1994; Argentina in 1914, 1931, 1976, and 1992; Mexico in 1912, 1932, 1982 and 1996; Chile in 1919, 1930, 1972 and 1982; Colombia in 1932 and 1980; and Venezuela in 1923, 1931, 1979 and 1989.

A common feature of these coefficients is their instability across sub-periods. This is probably due in part to the quality of the data (particularly for investment in the early period) and in part to the effects of notably increased GDP volatility in the early and late sub-periods. More worryingly, despite the use of lags in the regression equation, this coefficient instability could also imply reverse causation – e.g. rapid growth attracting labour and capital from abroad.

None the less, the coefficients for the factors of production estimated over the whole sample ('all'), in the three larger economies add close to unity, with the share of labour being relatively higher in Mexico. The trend variable reflecting structural change proved to be significant for all economies except Brazil and Venezuela; while logically labour plays a relatively minor role in the two mineral economies (Chile and Venezuela). The contribution of capital is surprisingly erratic, its main role apparently being in the middle decades of the century associated with state-led industrialisation and import protection. The structural-change trends concentrate their contribution during the early period, which is consistent with the fact those years witnessed a significant decline in the importance of agriculture in favour of manufacturing. The exception is Mexico, where the positive effect of a more efficient allocation of resources is located in the middle and late periods.

Feedback coefficients and short run effects on GDP growth

Tables 3A and 3B present the outcome of the ECM regressions themselves. All variables with the exception of the US real interest rate and the share of gov ernment expenditure on GDP are expressed in growth rates. All the feed-backcoefficients estimated over the whole sample proved to be statistically significant and with the right sign, with the highest value being for Chile (-0.33) and the lowest for Argentina **(**–0.15). This result means that in each of the countries there exists a long-run equilibrium relationship between GDP and the main factors of production, and that in the face of shocks there are forces that act to move the economy towards the equilibrium position.

Table 3A: Growth Analysis based on ECM

	Argentina				Brazil				Mexico			
Dep. Var: **GDP growth**	all	early	middle	late	all	early	middle	late	all	early	middle	late
Period	1900-2000	00-45	45-75	76-00	1900-2000	00-34	35-61	62-00	1900-2000	00-38	38-75	75-00
Immediate effect												
(variables in growth rates)												
GDP (t-1)	0.05	-0.05	0.24	0.33	0.19	-0.03	-0.29	**0.33**	0.05	-0.13	0.11	**0.25**
Capital (lagged)	-0.20	-0.31	**0.63**	**1.65**	**0.26**	0.11	**0.49**	0.59	**0.24**	-0.37	-0.06	0.29
Labour force (t-1)	**0.63**	**0.74**	0.31	3.85	0.11	**-3.75**	-1.83	1.50	0.00	0.74	0.00	0.00
World Demand	**0.12**	0.05	0.11	-0.10	**0.11**	**0.21**	-0.05	0.28	**0.17**	**0.29**	**0.11**	**0.29**
Terms of Trade	**0.08**	**0.08**	**0.14**	0.05	0.03	0.00	0.04	-0.02	0.01	0.02	**-0.09**	**0.17**
Terms of Trade (t-1)		**0.09**			0.05		0.05	-0.03	-0.08		-0.12	
US real int. rate *(levels)*	-0.09	-0.05	-0.25	**-0.54**	-0.05	-0.02	0.08	0.21	**-0.12**	0.00	-0.09	0.14
Gov. Exp % GDP (t-1)	-0.16	**-0.64**	-0.16	0.82	-0.08	**-0.83**	**-1.28**	-0.07	-0.08	-0.30	-0.06	-0.17
Feed-back effect	**-0.15**	-0.11	**-0.26**	**-0.66**	**-0.18**	**-0.32**	**-0.86**	-0.03	**-0.21**	-0.19	-0.12	**-0.25**
(t-statistics)	*-2.35*	*-0.78*	*-2.56*	*-3.30*	*-2.86*	*-2.11*	*-3.17*	*-0.37*	*-3.15*	*-0.85*	*-0.98*	*-3.22*
Adjusted R2	0.40	0.48	0.52	0.22	0.25	0.33	0.44	0.44	0.39	0.31	0.12	0.83
S.E.	0.039	0.037	0.033	0.044	0.035	0.034	0.024	0.032	0.034	0.043	0.023	0.017

Coefficients in **bold** are statistically significant at the 5% level.

Table 3B: Growth Analysis based on ECM

	Chile				Colombia				Venezuela			
Dep. Var: **GDP growth**	all	early	middle	late	all	early	middle	late	all	early	middle	late
Period	1909-2000	09-45	38-71	71-00	19'25-1998	25-48	46-75	75-98	1920-2000	20-45	46-77	78-00
Immediate effect												
(variables in growth rates)												
GDP (t-1)	**0.23**	0.08	-0.19	0.23	**0.31**	**0.64**	-0.20	-0.09	**0.45**	**0.40**	**0.28**	-0.17
Capital (lagged)	0.48	0.77	-0.58	-0.44	-0.22	-0.33	**-0.20**	-0.19	0.10	0.30	0.17	-0.33
Labour force (t-1)	-0.55	-2.00	**1.57**	2.08	**0.93**	-1.46	0.50	0.24	-0.18	-0.49	-0.26	3.62
World Demand	**0.46**	**0.84**	-0.11	**0.98**	-0.02	-0.05	-0.06	**0.24**	**0.17**	0.20	0.10	-0.18
Terms of Trade	**0.12**	0.16	0.00	0.05	**0.03**	**0.11**	**0.07**	-0.02	0.01	**0.20**	-0.03	**-0.07**
Terms of Trade (t-1)	**0.12**	**0.25**		-0.30					0.04	0.06		
US real int. rate *(levels)*	**-0.26**	-0.27	0.10	**-0.66**	0.11	**0.24**	-0.03	-0.05	**-0.18**	-0.01	**-0.34**	-0.24
Gov. Exp % GDP (t-1)	0.04		**0.31**	**-0.67**	-0.18	0.14	**0.55**	-0.39	-0.18		**-0.36**	**-0.62**
Feed-back effect	**-0.33**	-0.19	**-0.65**	**-0.30**	**-0.23**	**-0.37**	**-0.53**	-0.05	**-0.19**	-0.15	**-0.25**	**-0.26**
(t-statistics)	*-3.25*	*-0.96*	*-3.54*	*-2.20*	*-3.07*	*-2.13*	*-2.69*	*-0.44*	*-2.76*	*-0.75*	*-2.39*	*-2.02*
Adjusted R2	0.38	0.43	0.52	0.65	0.29	0.53	0.49	0.37	0.46	0.36	0.48	0.42
S.E.	0.066	0.093	0.024	0.035	0.019	0.021	0.014	0.014	0.046	0.067	0.026	0.034

Coefficients in **bold** are statistically significant at the 5% level.

Underlying the differences in the feedback coefficient there is a combination of factors, such as: the exposure to volatility in the growth drivers; differences in the response to shocks of both external and internal origin by both public and private sectors; and the particular structure nature of the economy – i.e. how flexible the output and trade systems are. Our results indicate that those countries with relatively less open economies over the century such as Argentina and Brazil tend to have smaller feedback coefficients.

Regarding the short-run impacts, in the case of Brazil, for instance, the results over the whole century indicate that around a quarter of GDP growth was due to investment. Meanwhile the coefficient of lagged output growth proved not to be significant suggesting a weak link between current growth and past performance. However, the significance of the error correction coefficient means that contemporary shocks had permanent effects via its impact on the economy's relative position to its long-run equilibrium. Turning to external variables, one standard deviation of the contemporaneous growth in foreign demand (7.5%) adds 0.8% to GDP growth.

Table 4: Impact of Immediate Effects on GDP growth (in %)

variables in growth rates	**Argentina**	**Brazil**	**Mexico**	**Chile**	**Colombia**	**Venezuela**
GDP (t-1)	0.3	0.8	0.2	**1.9**	**0.8**	**2.9**
Investment	-0.6	**1.0**	**0.9**	1.2	-0.4	0.5
Labour force	0.6	0.1	0.0	-0.4	0.6	-0.2
World Demand	**1.0**	**0.8**	**1.8**	**3.8**	-0.2	**1.3**
Terms of Trade	**1.0**	0.6	0.2	**1.6**	**0.5**	0.3
US Real Interest Rate *(in levels)*	-0.8	-0.4	**-1.0**	**-2.1**	**0.9**	**-1.4**
Gov. Expenditure *(as % of GDP)*	-0.5	-0.6	-0.6	0.2	-1.2	-1.0
GDP avg. growth rate	*3.2*	*4.4*	*3.7*	*3.4*	*4.2*	*5.3*

Results in **bold** are statistically significant at the 5% level.

Table 4 summarises the growth impact of changes in the variables under consideration in each of the countries based on the coefficients estimated over the whole sample. In particular, it presents information on the gains or losses in GDP growth that would occur if a particular regressor were to change by one standard deviation relative to its mean value (see Appendix II for information on mean and standard deviation values for all variables over the whole sample). For instance, in the case of the terms of trade in Argentina, one standard deviation over its average growth rate would add 1% to current GDP growth (which results from multiplying the variable's coefficient by its standard deviation over the period, i.e., 0.08*13.3). And in Chile a boost in world demand growth by one standard deviation (8.3%) translates into a 3.8% increase in GDP growth

(0.46*8.3%).

The results for the impact of external shocks suggest that fluctuations in the terms of trade and changes in world demand have played an important role in explaining GDP growth, but that their relative contribution varies across countries and sub-periods. There are significant correlations in the case of Argentina, Chile and Colombia over the whole sample. In Venezuela there is little evidence of a link between changes in the terms of trade and GDP growth – despite the fact that the country benefited from various oil bonanzas throughout the century – probably due to 'Dutch disease' problems and the effect of OPEC quotas.

None the less, the impact of changes in world demand over the whole sample proved to be significant in all six countries with the exception of Colombia. Regarding sub-periods, the coefficient of foreign demand lacks significance during the middle period (when economies were more protected) in all countries except Mexico – which is the most exposed to the US business cycle. The early period shows a significant growth role for foreign demand in Brazil, Mexico and Chile; but in the late period it proved only to have a role in Mexico, Chile and Colombia. The regressions over the century show significant coefficients for the US real interest rate – and with the appropriate sign – in the cases of Mexico, Chile and Venezuela. According to our estimations, its growth impact has been more marked in Venezuela and Chile. However, the level of significance is not robust across periods, particularly in the late period (only with significant correlations in Argentina and Chile) where it is expected to reflect the role of the rise in interest rates in the US in triggering the debt crisis.

Turning to the contribution of changes in endogenous variables, the evidence is also mixed. Past GDP growth plays a significant role in the mid-size economies of Chile, Colombia and Venezuela, where it determines between 20% to 45% of current growth – also indicating the persistence of shocks. However, past investment is significant over the whole sample in Brazil and Mexico. In Argentina the coefficient associated with endogenous variables over the whole sample failed to be significant at the 5% level. However, past investment had a significant and positive contribution during the middle and late periods. In Venezuela the negative contribution of investment in the late period reflects the failure of the major investment projects carried out during the 1970s and early 1980s to deliver results. Finally, the share of public spending on GDP did not prove to be a relevant growth driver (or indeed a constraint) in any of the countries over the whole sample.

3. Testing for Convergence using Panel Data

In this section we test for absolute and conditional convergence using panel data analysis. We start by comparing growth performance between the six countries in the region in terms of the process of 'homogenisation' or regional convergence. The fact that our group of countries has similar institutions and a common history, few language barriers, and similar lags in assimilation of technology should facilitate the process of convergence. Then, we proceed to assess the possibility of catching up to the US. See Appendix II for a description of variables and typical values.

The neoclassical growth model

In order to test for conditional convergence at the regional level, we start by using the standard model framework as in Barro & Sala i Martin (1995). The general convergence equation relates GDP per capita growth to three types of variables: initial conditions of state variables such as the stock of physical and human capital; control variables such as the ratio of domestic investment to GDP, the ratio of government consumption to GDP; and environmental variables (largely exogenously determined) such as changes in the terms of trade and measures of political instability.

We group our growth regressors into variables that tend to be exogenously determined (similar to the 'environmental' variables) and those that are to a large extent endogenous, i.e., path dependent or under the influence of government and individuals within a particular country. This second category resembles the state and control variables of Barro and Sala i Martin.

The dependent variable is GDP growth or productivity growth (GDPW), both expressed as annualised averages over each decade.[13] The set of explanatory variables includes those related to the specification of the standard Solow model as well variables to account for external factors and structural transformations. They are:

- Initial level of per-worker output, calculated as three-year averages at the start of each decade. The inclusion of GDPW proxies the initial level of physical capital per worker. We also include life expectancy (LIFE) to represent the initial level of health and the illiteracy rate (ILLIT) as proxies for the stock of human capital.[14]

[13] We use circa values (three year annual averages) in order to minimise distortions caused by abnormal values at the beginning and end of the decade.

[14] Another variable usually included in growth regressions to account for human capital is enrolment in primary education as a share of non-economically active population. However, we are leaving it aside here for lack of data across all countries over the century.

- The levels of state variables tend to be highly correlated, particularly GDP per worker and life expectancy and, to a lesser extend, the illiteracy rate. To avoid problems of multicolinearity, we incorporate state variables other than GDPW in the form of average growth rates per decade. For instance, in the case of life expectancy, instead of using the lagged levels we use the variable's annualised growth during the previous decade (d2LIFE).
- Investment share on GDP (IGDPAVG), obtained by averaging the annual share of investment on GDP over each decade.[15] Also we measure the saving effort by net investment (dKAP). Although both measures are highly correlated, the significance of their coefficients tends to differ, particular when instruments are included in the regressions (see below). We also include a variable for government in the form of the average share of public spending on GDP per decade (EXPGDPAVG).

We incorporate five external variables, namely:

- The barter terms of trade (NBTT), expressed as the annual average rate of growth over each decade and its standard deviation (NBTTSD), as a measure of volatility.
- The countries' income terms of trade (ITT) and a proxy for foreign demand (WDEM)[16] – with both variables entering the regressions as annual average rate of growth per decade.
- The average US real interest rate (USRIRATE) per decade to reflect changes in international financial markets.

There are three dummy variables related to major external events: the first reflects the impact of the 1929 crisis (CRISIS29), the second its aftermath (DEPRES30) and the third the debt crisis of the 1980s (DEBT80).[17]

Our third group of variables stands for structural and institutional transformations. In contrast with the external and control variables, their impact tends to occur gradually:

[15] Under the neoclassical framework, a higher savings rate (equivalent to the investment rate in a close economy) raises the steady-state level of output per worker, and for a given initial conditions implies a higher growth rate.

[16] Calculated as the combined volume import indices of the main trading partners weighted by each country's trade share during the period.

[17] Note that the impact of the Great Depression is also partly reflected in the external variables such as terms of trade and world demand, whilst the negative impact of the debt crisis in the capital account may be partly accounted for by the US interest rate.

- The share of agricultural value added on GDP (AGRI) accounts for industrialisation.
- The share of value exports on nominal GDP at the start of each decade (OPENX) which proxies the country's degree of integration into the world economy.[18]
- The share of customs taxes on fiscal revenues (CUTAX) used to capture changes in institutional development (or 'governance'). The idea here is that economic development goes hand in hand with a more complex and wider-based tax system funded by internal activities rather than international trade.

The absence of long-term data and conceptual measurement difficulties means that we do not include other variables related to domestic prices, political factors, and natural resource availability. Inflation is very difficult to handle over the long run because of the extreme fluctuations in the CPI indices in at least three of our six countries.[19] As to the inclusion of political factors, the relationship between political regimes and economic growth is ambiguous and empirical work on a wider sample of countries has not been conclusive (Alesina and Perotti, 1994). Regarding the contribution of natural resources, commonly used measures such as land area are inadequate to account for the discovery of minerals – a crucial factor in Mexico, Venezuela and Chile. However, to some extent this effect is incorporated in the initial level of GDP per worker.

[18] This is a rough measure of openness compared to those that focus on trade policy (e.g. Sachs and Wagner, 1995). However, in order to cover the whole century, we need to rely on less sophisticated measures.

[19] However, De Gregorio & Lee (2000) found a negative correlation between the inflation rate and growth, as well as between the volatility of inflation and growth – largely via investment – during the 1965–1999 period in a sample of 21 countries. The negative correlation remained once countries with high inflation were excluded from the sample.

Endogenous and Exogenous Factors

Table 5 summarises the outcome of a set of regressions to test for convergence in the region. We start by estimating a simple model that relates the growth rate of GDP per capita (dGDPW) with the initial level of GDP per worker (LGDPWt–1) and the rate of growth of life expectancy lagged one decade (d2LIFE). Regression (1) confirms the presence of regional convergence. The coefficient of LGDPWt–1 (–0.014) is significant and with the right sign. It indicates that regional convergence occurred at the rate of

Table 5: Traditional Convergence Regressions

Dependent variable	DGDPW = annualised average rate of growth of GDP per worker						
	(1) Absolute	**(2) Endogenous**	**(3) Exogenous**	**(4a) Extended model** *igdp*	**(4b)** *dkap*	**(5a) Extended model TSLS** *igdp*	**(5b)** *dkap*
C	**0.11**	**0.10**	**0.08**	**0.14**	**0.09**	**0.13**	**0.11**
State variables							
LGDPw(-1)	**-0.014**	**-0.015**	**-0.009**	**-0.019**	**-0.012**	**-0.019**	**-0.014**
d2LIFE	**1.00**	0.40		0.28	0.05	0.28	0.04
d2ILLIT							
Policy variables							
IGDPAVG		**0.161**		**0.148**		0.155	
dKAP					**0.482**		**0.355**
EXPGDPAVG		-0.03		-0.04	-0.05	-0.03	-0.02
OPENX(-1)		-0.03	0.01	0.01	0.01		0.02
External variables							
WDEMg			**0.221**	**0.197**	0.099	**0.185**	0.120
NBTTg			-0.013		**-0.068**		
NBTTSD			**-0.062**	**-0.069**		**-0.067**	**-0.048**
USRIRATED			-0.07	0.03	0.07	0.03	0.01
DEBT80			**-0.017**	**-0.017**	**-0.016**	**-0.017**	**-0.015**
CRISIS29			**0.020**				0.01
Structural & Institutional change variables							
d2AGRI		**-0.56 ***		-0.077	0.093	-0.075	0.00
d2CUTAX		-0.016				0.06	
Adjusted R-squared	**0.27**	**0.56**	**0.49**	**0.54**	**0.71**	**0.66**	**0.67**
S.E. of regression	0.017	0.013	0.406	0.013	0.011	0.012	0.011
Observations	54	54	60	54	54	54	54
Instruments						IGDPAVGT1 ; dITT	d2KAP ; dITT

(*) uses **dAGRI** (annualised rate of growth during the current decade)
Coefficients **in bold** are statistically significant at the 5% level.

1.4% per year. The regression also shows that one standard deviation from the average annualised growth rate of life expectancy over a decade improves productivity growth by 0.6% per year in the following decade.[20]

[20] This result of multiplying the standard deviation of dLIFE (0.006) by the variable's coefficient in the regression (1.0). When used instead of GDP per worker, the initial level of life expectancy also shows a negative correlation with GDP per worker growth. The same is true for the initial level of literacy and the initial value of the share of agriculture (but here with a positive sign).

Regressions (2) and (3) focus on the contribution of exogenous and endogenous factors taking each set of factors separately. Each set of variables explain at least 40% of the changes in the productivity growth rate as measured by the adjusted R^2, with the endogenous factors accounting for a larger share of the fluctuations. Initial conditions are significant in both cases, but the convergence rate is faster under the endogenous model (1.5% versus 0.9%). This is consistent with the fact that the endogenous regression includes crucial forces affecting the position of the steady state such as the savings rate.

In (2) the negative and significant coefficient of annualised change in the share of agriculture value added (–0.56) confirms the expected role of structural changes in advancing regional convergence. The investment share also has a positive contribution (0.16). In regression (3) with exogenous variables, the average annual growth of foreign demand over each decade (WDEMg) appears as the main external contributor to growth. Terms of trade growth is not statistically significant,[21] but their volatility is significant and with a negative coefficient, as modern investment theory would predict. The dummy for the debt crisis confirms its severe consequences for the region's living standards. However, the inclusion of the measure of openness to international trade (OPENX) – in different forms and lags – proved not to be significant.

The importance of foreign demand is also stressed by Cardoso and Fishlow (1989) in a panel data study with 18 Latin American countries over the 1950–80 period, where both export expansion and import growth are shown to be key contributors to output growth in the region. De Gregorio (1991) in a study including 12 countries over a similar period also reports lack of significance of terms of trade and trade openness. Our results for terms of trade *volatility*, however, appear to be both novel and plausible.

Regressions Including All Factors

The remaining regressions in Table 5 combine both endogenous and exogenous factors. We start by presenting estimates obtained by the Ordinary Least Square method. Regressions (4*a*) and (4*b*) give a comparison of results using different measures for the savings rate: first as the average share of investment of GDP over each decade (IGDPAVG) and second as the annualised growth of capital (dKAP).

The pace of convergence is estimated in a range of between 1% and 2 % per annum. The standard deviation of the terms of trade (NBTTSD) proved to be significant in (4*a*) whereas their rate of growth (NBTTg) worked better in (4*b*). As before, the debt crisis dummy is significant and with the expected sign. Meanwhile, world demand was signifi-

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[21] An improvement in the terms of trade obviously raises national income; but the impact on production – and, in consequence, on the steady state position – is theoretically ambiguous because it depends on the effect of resource reallocation in response to relative price changes.

cant only in (4a). The measure for structural change, now entering the equation with one decade lagged (d2AGRI), failed to be significant.[22] The same was true for trade openness, the average share of government expenditure, the US real interest rate and the lagged life expectancy growth (d2LIFE).

One common concern of the empirical literature is that given the association between contemporaneous changes in GDP and investment, the explanatory power of the investment ratio may reflect reverse causation (Temple, 1999). This endogeneity problem can be dealt with by using instruments during the estimation procedure, usually in the form of lagged values of the endogenous variables. To this effect we use Two-Stage Least Square (TSLS) as the testing procedure in regressions (5*a*) and (5*b*).[23]

The explanatory power of the regressors changed little by the inclusion of these instruments. The convergence coefficient remains in the 1–2 % range. Regressions (5*a*) and (5*b*) provide evidence of the impact of uncertainty and fluctuations in the terms of trade (NBTTSD) on productivity growth. In the first case, the coefficient of –0.067 indicates that an increase of 5 % in such volatility results in an annual fall of 0.3 % in GDP per worker growth.[24] The results of (5*b*) indicate that one standard deviation increase in the investment effort (i.e., net investment growth of 2.6% per year higher than the region's average rate of 3.6% per year) is associated with productivity growth gains of 0.9 % per year. Meanwhile, the growth rate of the terms of trade again failed to be significant; while the dummy for the 1980s debt crisis is statistically significant. The implication is that the crisis resulted in a decline of 1.5–1.7 % per year in GDP per worker growth during the decade.

One main difference to highlight when comparing (5a) and (5b) is that the IGDPAVG coefficient looses its significance. This is a common feature of the empirical growth literature (Barro & Sala i Martin, 1995, p.432), and it is usually interpreted as an indication that the causal link runs from productivity growth to investment. However, the fact that by using a closely related variable (dKAP) we are able to keep the significance of the coefficient suggests this may not be the reason, and that the problem is more likely to be caused by limitations in the data.

[22] Because of their correlation with initial values of GDP per worker and life expectancy, variables reflecting structural and institutional transformations enter the regressions in the form of changes over a decade.

[23] As instruments for the investment variable we use its lagged value and the contemporaneous growth of the income terms of trade (dITT). Regression of IGDPAVG with its own lagged value and dITT, gives an R^2 of 0.42 and significant coefficients.

[24] We also tried regressions including fixed effects to account for countries' specificities. In general, the coefficients of the country dummies failed to be insignificant.

Convergence in an ECM framework

In this section we adopt the Error Correction Model as an alternative formulation to test for convergence in income among countries.[25] The use of the ECM specification is also consistent with the annual models in the previous section. Table 6 presents the outcome of two different exercises. The first looks at real GDP convergence to long run potential (regressions 1a and 1b), as measured by the factors of production and the structure of the economy. The second exercise tests for the occurrence of catching up to the level of GDP per worker in the US.

We begin by testing an ECM formulation similar to the one adopted in the analysis based on annual time series in Section 2, in order to assess the average long-run characteristics of the growth process in the region as proxied by the six larger economies. Moreover, the use of panel data allows us to test for additional factors that are likely to have an impact over a longer period of time (such as the role of government, trade integration, improvement in human capital and structural and institutional transformations) but which are not measurable on an annual basis.

As in the previous section, we use a two-stage procedure that first estimates the long-run equation and then uses the resulting residuals (lagged one period) to estimate the ECM coefficient and the growth effects. Note that here observations are a decade apart, so the 'short-term effects' of the time series models become 'transitional effects' towards a steady state (as captured in the long-run equation). We estimated the following long-term equation with all variables in logs (values in bold are statistically significant at 5% level):

*LGDP = **–0.21** + **0.65***LKAPt1 + **0.44***LEAP – **0.24***LAGRISH*

The stock of capital enters with one decade lagged to avoid problems of reverse causation. All three long-term factors are significant and with the appropriate sign. The coefficient of the share of agriculture on GDP is negative indicating that the lower the relative importance of agriculture the higher the level of output.

Regression (1*a*) in Table 6 shows the results of GDP growth with a similar set of factors as in the time series models; while in (2*b*) we add variables to account for government and structural transformations. The feedback coefficients indicate that the gap

[25] Foreman-Peck and Lains (2002) use a similar approach in their study of convergence in the European periphery during the period 1870–1914.

Table 6: Error Correction Model Regressions				
Dependent variable	DGDP (annualised GDP growth)		DGDPW (growth per worker)	
	(1a) **ECM GDP**	**(1b)** **ECM GDP**	**(3a)** **catch up**	**(3b)** **catch up**
C	0.02	0.01	-0.01	-0.01
d2GDP	**0.50**	**0.35**		
d2GDPw			0.11	0.10
Transition effects				
External				
WDEMg	**0.293**	**0.255**	0.120	**0.207**
NBTTg	0.069			
NBTTSD	**-0.117**	**-0.061**	**-0.06**	**-0.06**
USRIRATED	**-0.13**	-0.06	0.02	0.03
DEBT80	**-0.023**	-0.013	**-0.023**	**-0.018**
Policy related				
IGDPAVG			**0.14**	**0.12**
EXPGDPAVG		-0.05	**-0.11**	**-0.10**
OPENX	0.052	0.04		-0.01
Structural & Institutional change				
dAGRI		**-0.685**		-0.12 (*)
dCUTAX		-0.01		-0.01
d2EAP	-0.06	0.44		
d2ILLIT		0.28		
Feedback effect				
ECM GDP [IGDP-LKAP-LEAP-LAGRISH]	**-0.025**	**-0.025**		
Catch up [LGDPW - LGDPUS]			**-0.013**	**-0.015**
Adjusted R-squared	**0.21**	**0.54**	**0.363**	**0.437**
S.E. of regression	0.019	0.014	0.016	0.015
Observations	**54**	**54**	**54**	**54**

(*) uses d2AGRI (annualised rate of growth during the previous decade)
Coefficients **in bold** are statistically significant at 5%.

between the initial and long-term positions at the beginning of each decade is reduced by 2.5% per year. This is consistent with a tendency to convergence towards output potential, in the sense that an initial position below the long-run equilibrium results in an increase in the rate of growth of output. Meanwhile, the inclusion of additional factors in (1*b*) improves the regression's explanatory power but results in little change in the responsiveness of GDP growth rate to the long-run gap measured in terms of factors of production.[26] There is a positive correlation between past and current growth (in terms of decades), indicating persistence of shocks. Regarding transitional effects: world de-

[26] Note that the size of the region's feedback effect is significantly lower than estimates obtained on a country-by-country basis using annual series. That is, the simple average of the feedback coefficient of the six countries (see pp. 11–12) is 0.22 compared to 0.025 with panel data. This can be explained by the fact that fluctuations are significantly reduced after aggregating through time and across geography.

mand, terms of trade volatility, US real interest rates, (only in 1*a*) and changes in the share of agricultural value added all have significant coefficient with the expected signs. In particular, the coefficient of –0.06 of NBTTSD in (1*b*) indicates that a 5% increase in terms of trade volatility reduces GDP growth by 0.4%.

Finally, we can also use the ECM model to test for catching up with the US. In this case the long-term component measures deviations of output per worker with respect to the US value. The two feedback coefficients of regressions (3*a*) and (3*b*) are significant and with the appropriate sign (–0.013 and –0.015). This is consistent with catching up at a slow pace, in the sense that an initial position below the US GDP per worker results in a rise in the rate of growth of output per worker in the group of Latin American countries.

Regarding transitional effects, regression (3*a*) shows positive correlations with world demand and the savings rate, and a negative link with the share of government expenditure, the average growth in the terms of trade and the debt crisis. In (3*b*) we include the savings ratio, dAGRI and dCUTAX. The significance of the changes in the share of agriculture confirms the positive impact on growth of a more efficient allocation of resources. However, foreign demand loses its significance.

That the ECM results in Table 6 should demonstrate conditional catching up is at odds with conventional belief – although it is consistent with economic theory. One way of interpreting this result is that there are long-run forces at work that reduce the gap in output per worker between the leader and the followers, particularly technological transfer but also institutional learning. However, the occurrence of contemporaneous shocks impact negatively on the growth engine widening the output gap again. Because of this Sisyphus-like process the region has not been able to profit from the positive forces of convergence.

Indeed, there was some narrowing of the productivity gap with the US in the 1930s, and again from 1950 to 1980. The first catch-up was a consequence of the fact that the Great Depression had a far greater impact on the US. In the larger economies in Latin America, proto-Keynesian policies were implemented to stimulate domestic demand and save scarce foreign exchange, and this helped to mitigate the effects of depressed world demand (Thorp, 2000). The second catch-up was due to the relatively rapid pace of industrialisation in Latin America during the immediate post-war decades. However, the last quarter of the century was dominated by developments pulling the US and the Latin American economies in opposite directions. This was the combined effect of the region's poor growth record at a time when the US was experiencing a technology-based boom. Divergence with respect to the US is a thus a widespread feature of Latin America during the closing decades of the twentieth century.

4. Conclusions

Our analysis of the contribution of both endogenous and exogenous factors to economic growth and productivity in Latin America during the twentieth century is not a simple one, with extensive variance across countries and periods. Our six countries clearly differ considerably in the relative importance of growth factors, in the exposure to exogenous shocks, and in the speed of adjustment to deviation from the long-term path. The multivariate models also reveal differences in growth factors across sub-periods.

Our findings on structural breaks confirm the disruptions to growth caused by the Great Depression around 1930; but the breaks around 1980 are less synchronised and in a number cases preceded the 'debt crisis' symbolised by Mexico's 1982 moratorium. For example, by the late 1970s the Venezuelan economy had already started to slow down, while the Argentine economy was experiencing difficulties with its growth engine by the mid 1970s. Overall, Colombia is the country with the smallest degree of parameter instability over the century, whereas the Chilean economy is the country most affected by severe discontinuities.

Main findings on growth and convergence

(i) Although coefficient instability across sub-periods makes it difficult to identify consistent patterns, the results indicate that that capital accumulation had a more prominent role during the middle period of the century, when our six countries were relatively closed to the world economy and state-led industrialisation was being accelerated. In contrast, the poor contribution of investment to growth in the closing decades of the century, characterised by extensive market reforms, is a source for serious concern.

(ii) The six main economies did converge considerably over the century due to improvements in resource allocation, advances in health and education and increased investment effort: the dispersion in both GDP per worker and per capita in 2000 is considerably lower than in 1900. We have identified a number of key drivers of the process of homogenisation among the larger Latin American economies; such as: improvements in resource allocation, advances in health and education and increases in the investment effort. However, our results suggest that the potential for homogenisation has largely been realised already.

(iii) There was no sustained catching up between Latin America and US. The within-group convergence was insufficient to reduce the gap between Latin America and the US – and indeed there was strong divergence from comparable industrialising areas such as Southern Europe and East Asia (Astorga, Bergés and FitzGerald, 2003b). Our results demonstrate, rather a process resembling the classical 'curse of Sisyphus' – any temporary progress made in closing the gap was then eroded by external economic and domestic political shocks.

(iv) Terms of trade *volatility*, trade fluctuations and interest rate shocks were major obstacles to both sustained economic growth and catching up. It is difficult to assess whether these were more important than domestic shocks as the latter were often associated with the former. The trade and interest rate effects are confirmed by other studies, but terms of trade volatility result is new, and suggests that effect may be through the impact on investor expectations rather than through import capacity as previously argued.

Implications

Despite a significant effort in modernisation and industrialisation over the century, Latin America has clearly fallen behind relative to the rest of the industrialising world, particularly in the last twenty-five years. The combined evidence of convergence in life expectancy relative to the US and the failure to close the productivity gap during the last century suggest important variations in the diffusion of scientific and technologic innovations. Whereas advances in medicine and sanitation crossed national boundaries with relative ease, the same does not seem to be true for production innovations. This in turn might imply unexpected differences in technology adsorption and institutional innovation between the public and private sectors respectively.

Our finding that external shocks and terms of trade volatility were a major obstacle to sustained economic growth and catching up can be interpreted as supporting the need for improved multilateral coordination of trade and finance. Absent external shock reduction, then institutional changes at the national level (e.g., stabilisation funds, central bank independence, counter-cyclical fiscal stances) are imperative to minimising their impact. The comparison of the feedback coefficients, the degree of openness, and the volatility of the long-term factors should give some indication as to the role of policy response. For instance, if endogenously generated volatility and external shocks are similar for two or more countries, then our observed differences in the feedback effect (e.g. Chile versus Argentina) can be attributed to a more or less responsive economic policy. However, a larger coefficient of adjustment towards equilibrium position could well reflect a failure of policymakers to reduce the economy's exposure to shocks rather than to a success in responding to them.

Finally, although our quantitative analysis cannot, owing to data limitations, fully incorporate institutional factors, there is little doubt that a stable political environment and credible economic policy regimes would have raised growth and enabled some convergence with the US.[27]

Caveats

Our evidence on convergence *within* the six larger economies is robust. However, we have two caveats. First, the intra-regional convergence may be over-estimated due to the use of a single PPP adjustment factor (1970).[28] This may undervalue the 1900 GDP of countries which were much less open and industrialised then (e.g. Brazil) and thus make their estimated over-century growth rate higher relative to countries which were more so (e.g. Argentina). However, by extension, this caveat would mean that the observed lack of convergence of the group with the US might in reality mask a long-term *divergence*.

Second, our findings on growth and convergence for the largest six economies are representative of Latin America a whole because they account for three-quarters of population and output across the century. However, this does not mean that these results can be extended to the rest of the countries in the region. Indeed the remaining countries show an increase in dispersion in GDP per capita after 1950, resulting in the formation of two distinct 'convergence clubs'. Specifically, the smaller economies in the region (with key exceptions such as Costa Rica) display an inferior pattern of growth compared to the larger six – in the sense of both lower growth rate and greater volatility – which may possibly relate to their greater vulnerability to external shocks.[29]

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[27] After all, if the average growth rate of GDP per capita over the whole century had been one percentage point higher, the gap would have halved.

[28] PPP weights prior to 1960 are not available nor is it feasible to estimate them – see Astorga, Bergés and FitzGerald (2003*b*).

[29] See Astorga, Bergés and FitzGerald (2003*b*).

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Appendix I:
Analysis of Parameter Stability by Country

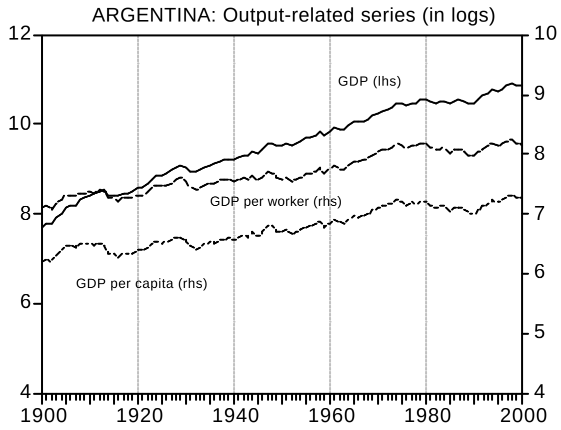
This note describes the test applied to the ARI models to assess parameter stability and structural breaks in the series of GDP and GDP per head. We use Recursive Least Squares (RLS). Under this procedure the equation is estimated repeatedly, using each time larger subsets of the sample data. If there are *k* coefficients to be estimated in the vector of coefficients (*b*), then the first *k* observations are used to form the first estimate of the set of coefficients. The next observation is then added to the data set and *k+1* observations are used to compute the second estimate of the regression coefficients. This process is repeated until all the *T* sample points have been used, yielding *T–k+1* estimates of the coefficients (Banerjee et all, 1992).

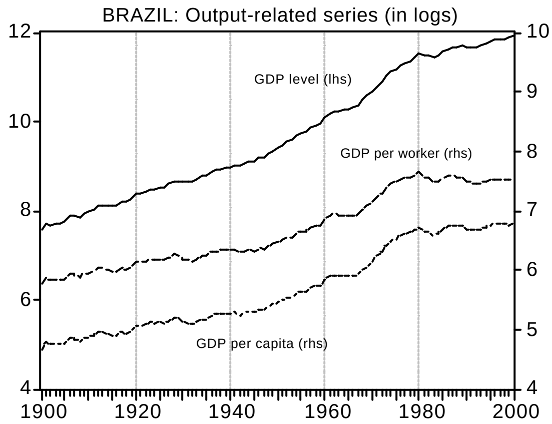
At each step the last estimate of *b* can be used to predict the next value of the dependent variable. The one-step ahead forecast errors resulting from this prediction, suitably scaled, are the recursive residuals. These residuals provide the basic information to test for structural breaks. We apply a number of tests for parameter stability where rejection is associated with the presence of structural breaks in the series. The basic tests for parameter consistency are the stability of *the vector of coefficients b*, the *sum square of residuals* (Cusumsq) and *one-step ahead forecast*. The Cusumsq test is based on the cumulative sum of the recursive residuals. The tests find parameter instability if the cumulative sum goes outside the area between the two critical lines. Finally, the one-step forecast provides information on those periods when the equation is least successful.

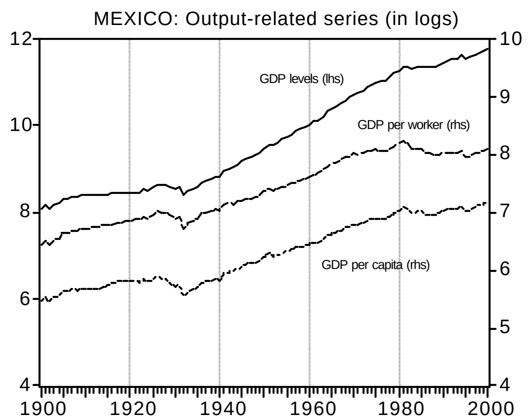
We test for structural breaks using the *Chow tests*. The idea of the breakpoint Chow test (Chow-B) is to fit the equation separately for each sub-sample and to assess whether there are significant differences in the estimated equations. A major mismatch indicates a structural change. Meanwhile, the Chow forecast test (Chow-F) estimates the model for a sub-sample comprised of the first *T* observations. The estimated model is then used to predict the values of the dependent variable in the remaining data points. A large difference between the actual and predicted values casts doubt on the stability of the estimated relation over the two sub-samples. Note that, although related, both tests do not need to lead to the same conclusions.

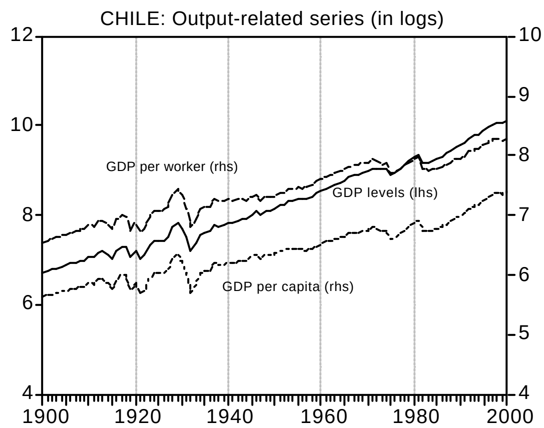
This statistical analysis enables us to assess parameter stability of series of GDP (local currency at constant prices of 1970), GDP per worker and GDP per capita. These series, although related, permit us to focus on different aspects of the process of development of the countries under analysis. While GDP refers to the evolution of economic activity, GDP per economically active worker is a proxy for labour productivity and

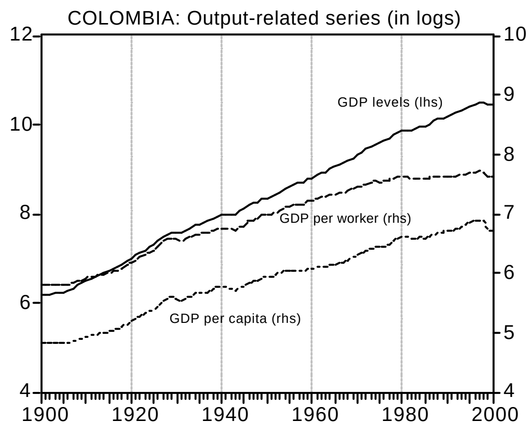
GDP per capita is used as a measure of welfare. A set of charts in the following page presents all three series by country over a hundred-year period.

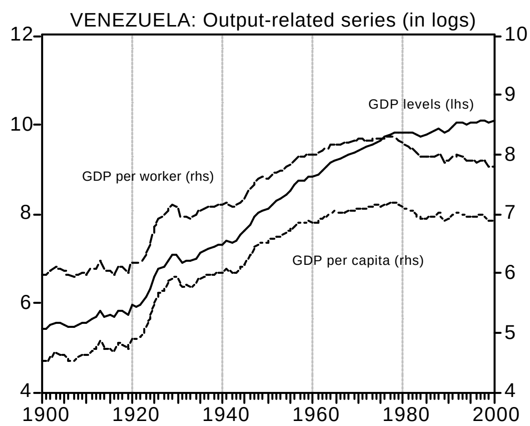












A structural break may be defined where there are significant differences in the fitting of a particular Autoregressive (AR) model across two consecutive sub-periods. That is often also associated with the predictive failure of a model and with parameter instability. The advantage of this approach is parsimony: it is economical in its data requirements. The AR model tries to explain current behaviour using only information provided by the past history of the time series.

The Recursive Least Squares (RLS) procedure estimates the coefficients repeatedly, using successively larger subsets of the sample data. The ARI models are chosen according to the autocorrelation properties of the series, with the ARI(1) as the most common model. In all six countries the series of GDP, GDP per worker and GDP per capita – after applying a logarithmic transformation – were found to be integrated of order one.[30] Consequently, we base the analysis on the first differences of the series. We also apply a number of tests for parameter stability where rejection is associated with the presence of structural breaks in the series. Among them the *breakpoint Chow test* (Chow-B) and the *Chow forecast test* (Chow-F). We also seek to identify the longest interval for which parameter stability can be maintained. That is, the horizon over which there is no major breakdown in the arrays of values for the coefficients.

Where strong evidence for a structural break is found, the sample is separated into sub-periods according to the date of the break, and the model is then tested again for parameter stability in each of the sub-periods. This procedure is repeated until the models exhibit parameter stability. In most cases, the tests are first performed over the period limited by the initial year of the longest period with relative parameter stability and the end of the century, and then over the beginning of the sample and the first year of the longest period of stability. Table 1 in the text summarises the dates for each of the six countries.

The Larger Economies: Argentina, Brazil And Mexico

In *Argentina* we found the longest period of stability to be between 1958 and 1975. In order to test for structural breaks, we performed both Chow tests on a ARI(1) model first over the period 1958–1990 – excluding the convertibility period. The Breakpoint tests (Chow-B) find evidence of a structural break around 1976 at a 1% level of significance for all three series. In addition, the Forecast tests (Chow-F) confirm the presence of a discontinuity at a 5% level of significance. This break is associated with the 1976 military coup against María Estela de Perón that resulted in a high level of social unrest and deep macroeconomic instability (Katz and Kosacoff, 2000). We also found evi-

[30] A non-stationary series is integrated of order one if the series is stationary after taking first differences. We use the augmented Dickey-Fuller (ADF) test framework to explore the possibility of unit roots. However, as Perron (1989) showed, failing to reject the ADF null hypothesis can be due to the presence of a structural break in the series.

dence of a break in the GDP series around 1992, this time by running an ARI(2) model over the period 1980–2000.

As to the first half of the period, we found evidence of a structural break in 1930 when estimating an ARI(1) over the period 1917–1958. Another candidate for a break in the GDP series is the recession during 1914–16, but none of the Chow tests reject the null hypothesis of 'no structural break' here. But, there is strong evidence of parameter instability around the mid 1910s.[31] Although outside the period covered in this paper, the end of the convertibility regime in December 2001 – and the unprecedented collapse of economic activity that followed – would certainly qualify as the first structural break in the Argentine economy for the new century.[32]

In the case of *Brazil*, the longest period of relative stability was between 1936 and 1960. In order to test for structural breaks we performed the Chow tests first over the period 1936–1978 and then over the period 1965–2000. They reject the null hypothesis of no structural break around 1963 for GDP per worker and per capita, but only Chow-B test in the case of GDP (see the corresponding country table at the end of this Appendix for level of significance). This date corresponds to the end of the golden age of import substitution in the country. The process of rapid growth of the 1950s was interrupted by a recession in 1962, which then made apparent the limits of the import substitution model (Abreu et al, 2000). There is also evidence of a discontinuity in all three series in 1981, with both tests rejecting the null in the case of GDP and GDP per capita and again, only the Chow-B in the case of GDP per worker.

As to the first half of century, the Chow tests do not provide consistent evidence of the presence of structural breaks. However, there is increased parameter instability during the years of 1929 and 1930. Part of the difficulty in finding evidence – as provided by the Chow tests – may be due to a high level of volatility in the series. Since the data are excessively 'noisy' this is reflected in AR models where the coefficients are not significantly different from zero.

Turning to *Mexico*, the lack of data during the period of the Mexican revolution (1911–19) and its aftermath means that the starting sample is limited to the period 1921–2000. However, the years of the Revolution should be taken as the first structural

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[31] The period of WWI is singled out by Cortes Conde (1997) as a change in direction of the growth process in the country, with the import shortages having a severe impact on industrial activity. In a study covering the period 1875–2000, Sanz (2004) found evidence of a structural break in the series of GDP per capita in 1913.

[32] Utrera (2001) found evidence in the Argentine GDP annual series (covering the 1913–1999 period) supporting the hypothesis of a stationary process around a trend with structural breaks in 1929 (in both intercept and slope), around 1979–80 and 1989–90 (the last two only in the slope). Regarding GDP per capita, following the same technique, he reports breaks around 1929, 1968 and 1987–88 (all of them in intercept and slope).

break of the century. In order to test for discontinuities in the series during the 1930s, we use the reverse series and perform the regression backwards so that we have enough observations to estimate the AR model before the break. We find both Chow tests indicating a structural break around 1930–31. The result also applies for GDP per worker and GDP per capita. As to the analysis during the second half of the century, there is evidence of a break around 1981 for all three series. Finally, the Chow-F test rejects the null of absence of structural break in 1995 in the series of GDP and GDP per worker.[33]

The medium-size economies: Chile, Colombia and Venezuela

In our six-country sample, *Chile* is perhaps the country with the longest episodes of instability. The charts above show large fluctuations around 1919–21 and 1930–32 in the first half of the century, and around 1972 and 1982 during the second half. The proximity of these periods of turbulence makes it difficult to test for structural breaks. In particular, for shocks in the early 1920s and 1930s the analysis is aggravated by the lack of 'real' data between 1900 and 1909.[34]

First, we test for structural breaks during the period 1938–1980. In all three series the Chow-F test indicates the presence of a structural break around 1973. After the military coup against the Allende government, the development strategy in Chile took a radical turn towards an open, privatised economy free from state intervention. The structural adjustment that followed caused a period of great economic instability. And that was aggravated by the 1974 oil shock (French-Davis et al, 2000). Because of the proximity of 1981–82, we use the reverse series of GDP to test for breaks. This way we can use 18 observations – from 2000 to 1983, instead of just 5 from 1974 to 1980 – to estimate the ARI model. By doing this we are in fact using 'the future' to explain 'the past', which creates problems of economic interpretation of the coefficients. But the break test procedure remains valid.

During the period 1923–1965 the Chow breakpoint test finds evidence of a structural break in 1933 for all three series using an ARI(1,4) model. However, we had little success in finding evidence of a structural break during the years around 1920, despite a strong indication of a significant discontinuity. The inability to detect a break here could well be due to the high level of volatility in the series during the first quarter of the century and a reduced sample of observations.

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[33] Noriega and Ramírez (1999) found that Mexico's real GDP and GDP per capita series (based on annual data from 1925 to 1995) have fluctuated stationarily around a long-term trend perturbed by three major breaks around 1931, 1950 and 1980. And in a study covering 1900–2001, Castillo and Díaz (2002) found evidence for GDP breaks in 1932, 1983 and 1995.

[34] We exclude data before 1910 because our GDP figures during the period are estimated assuming a constant rate of growth.

The starting sample for *Colombia* covers the period 1905–2000. The stability analysis indicates that the longest period of relative stability in Colombia's GDP is limited by 1945 and 1978. We looked for evidence of breaks during the second half of the century. Regarding GDP, the Chow-B test rejects the hypothesis of no structural break in 1980–82. The presence of a break around this date is also found in the series of GDP per worker. However, the Chow tests failed to reject the null hypothesis in the case GDP per capita. As to the earlier period, both Chow tests indicate the presence of a break in all three series around 1930.

Finally, in *Venezuela* the longest period of relative stability occurs during 1946–1977. In all three cases, both the Chow-B and the Chow-F test reject the null hypothesis of no structural break around 1978. Another possible candidate for a structural break during the second half of the century is 1989, which marks the beginning of a period of political instability in the country. But in this case the Chow tests did not provided conclusive evidence of a mayor discontinuity in the growth process. As to the earlier period, the Chow tests indicate the presence of a significant discontinuity in all three series around 1924 – the period when the country began oil production on a large scale (Astorga, 2000). There is also evidence of parameter instability around 1932 in the series of GDP – although the Chow tests fail to pick this up. Outside our period limits, the beginning of the new century (2002–3) provides a new structural break associated with efforts to oust President Chávez resulting in an unprecedented contraction of economic activity.

Structural Break Analysis using ARI Models

(first differences of series in logs)

Section	Method	Argentina	GDP	GDP per worker	GDP per capita
		Starting sample	1900-2000	1900-2000	1900-2000
		AR model ; R2 ; SE	ARI(1,2,8) ; 0.1 ; 0.046	ARI(2,8) ; 0.1 ; 0.045	ARI(1,2,8) ; 0.1 ; 0.046
Stability analysis	*Recursive Least Squares*	**Parameter constancy**	Period of instability: 1929-mid 30s	Instability 1929-mid 30s Step change around 1950	Instability 1929-mid 30s Step change around 1950
		Cusum of Squares	no apparent problems	no apparent problems	no apparent problems
		One-step Forecast (outliers)	1914; 1930-32; 1945; 1952; 1959; 1989	1914; 1930-32; 1945; 1959; 1989	1914; 1930-32; 1945; 1959; 1989
		Longest period of stability	1958-1975	1960-1975	1960-1975
		AR model ; R2 ; SE	ARI(2) ; 0.31 ; 0.038	ARI(2) ; 0.30 ; 0.034	ARI(2) ; 0.31 ; 0.033
Structural break tests	Chow tests	**(period ; model)**	1900-1928 ; ARI(1)	1900-1928 ; ARI(1)	1900-1928 ; ARI(1)
		Break: 1913-14	no rejection	no rejection	no rejection
			1917-1955 ; ARI(1)	1917-1955 ; ARI(1)	1917-1955 ; ARI(1)
		Break: 1930	Chow-F at 5%	Chow-F at 5%	Chow-F at 5%
			1955-1990 ; ARI(2)	1955-1990 ; ARI(2)	1955-1990 ; ARI(2)
		Break: around 1976	Chow-B at 1% ; Chow-F at 5%	Chow-B at 1% ; Chow-F at 5%	Chow-B at 1% ; Chow-F at 5%
			1980-2000 ; ARI(2)	1980-2000 ; ARI(2)	1980-2000 ; ARI(2)
		Break:1992	Chow-B at 2%	Chow-B at 5%	Chow-B at 5%
		Brazil	**GDP**	**GDP per worker**	**GDP per capita**
		Starting sample	1900-2000	1900-2000	1900-2000
		AR model ; R2 ; SE	ARI(1,2,8) ; 0.14 ; 0.037	ARI(1,2) ; 0.09 ; 0.039	ARI(1,2,8) ; 0.1 ; 0.037
Stability analysis	*Recursive Least Squares*	**Parameter constancy**	Step changes in 1930, 1973	Step change in 1930-31 Step change in 1970-71	Step change in 1930-31 Step change in 1970-71
		Cusum of Squares	no apparent problems		
		One-step Forecast (outliers)	prediction failure in 1914, 1942, 1972, 1981	Prediction failure in 1930, 1971, 1981	Prediction failure in 1930, 1971, 1981
		Longest period of stability	1935-1960	1935-1960	1935-1960
		AR model ; R2 ; SE	ARI(1,3) ; 0.35 ; 0.027	ARI(2,3) ; 0.32 ; 0.027	ARI(2,3) ; 0.33 ; 0.026
Struc. break test	Chow tests	**(period ; model)**	1900-1945 ; ARI(1)	1900-1945 ; ARI(1,4)	1900-1945 ; ARI(1,4)
		Break: 1930	no rejection of the null	no rejection	no rejection
			1935-1978 ; ARI(1)	1935-1978 ; ARI(1)	1935-1978 ; ARI(1)
		Break: 1960-61	Chow-B at 1% ;	Chow-B at 1% ; Chow-F at 5%	Chow-B at 1% ; Chow-F at 5%
			1965-2000 ; ARI(1)	1965-2000 ; ARI(1)	1965-2000 ; ARI(1)
		Break: 1981	Chow-B at 1% ; Chow-F at 5%	Chow-B at 2% ;	Chow-B at 5% ; Chow-F at 5%
		Mexico	**GDP**	**GDP per worker**	**GDP per capita**
		Starting sample	1935-2000	1935-2000	1935-2000
		AR model ; R2 ; SE	ARI(1) ; 0.03 ; 0.034	ARI(1) ; 0.05 ; 0.034	ARI(1) ; 0.01 ; 0.033
Stability analysis	*Recursive Least Squares*	**Parameter constancy**	Instability early 1930s	step change in 1982 step change in 1995	Instability early 1930s step change in 1995
		Cusum of Squares	Out of interval, max in 1982	Out of interval, max in 1982	Out of interval, max in 1982
		One-step Forecast (outliers)	1982, 1986, 1995	1982, 1995	1982, 1995
		Longest period of stability	1945-1975	1945-1975	1948-1978
		AR model ; R2 ; SE	ARI(1) ; 0.01 ; 0.029	AR(1) ; 0.03 ; 0.024	AR(1,3) ; 0.10 ; 0.025
Struc. break tests	Chow tests	**(period ; model)**	1970-1925 ; ARI(1)	1970-1925 ; ARI(1)	1970-1925 ; ARI(1)
		Break: 1930-31 (reverse)	Chow-B at 1% ; Chow-F at 1%	Chow-B at 1% ; Chow-F at 5%	Chow-B at 1% ; Chow-F at 5%
		Break: 1981-82	1943-1994 ; ARI(1)	1940-1994 ; ARI(1)	1943-1994 ; ARI(1)
			Chow-B at 1% ; Chow-F at 1%	Chow-B at 1% ; Chow-F at 1%	Chow-B at 5% ; Chow-F at 2%
		Break: 1995	1984-2000 ; ARI(1)	1984-2000 ; ARI(1)	1984-2000 ; ARI(1)
			Chow-F at 5%	Chow-F at 5%	No rejection of null hyp.
		Break: 1919-1925	lack of data	lack of data	lack of data

All series are integrated of order one at 1% of significant (ADF) exept GDP in Brazil and Mexico at 5%

Structural Break Analysis using ARI Models

(first differences of series in logs)

		Chile	GDP	GDP per worker	GDP per capita
		Starting sample	1909-2000	1909-2000	1909-2000
		AR model ; R2 ; SE	ARI(2,3,4) ; 0.09 ; 0.08	ARI(2,3,4,9) ; 0.125 ; 0.08	ARI(2,3,4) ; 0.09 ; 0.08
Stability analysis	*Recursive Least Squares*	Parameter constancy	Instability 1919-1921 and 1930-36	Instability 1919-1921 and 1930-36	Instability 1919-1921 and 1930-36
		Cusum of Squares	Out of interval, max in 1935	Out of interval, max 1935	Out of interval, max in 1935
		One-step Forecast (outliers)	1919, 1921, 1932, 1975, 1982	1919, 1921, 1932, 1937, 1975, 1982	1919, 1921, 1932, 1937, 1975, 1982
		Longest period of stability	1937-1971	1938-1971	1938-1971
		AR model ; R2 ; SE	ARI(1,3) ; 0.43 ; 0.03	ARI(4) ; 0.29 ; 0.031	ARI(1,4) ; 0.37 ; 0.028
Struc. break tests	Chow tests	(period ; model)	no rejection		
		Break: 1920-22	not enough observations	-	-
			1923-1965 ; ARI(1,4)	1923-1965 ; AR(1, 4)	1923-1965 ; ARI(1,4)
		Break: 1933	Chow-B at 1% ;	Chow-B at 1% ;	Chow-B at 1% ;
			1938-1980 ; AR(1,4)	1938-1980 ; AR(4)	1938-1980 ; AR(1,4)
		Break: 1973	Chow-F at 1%	Chow-B at 5% ; Chow-F at 1%	Chow-F at 1%
			2000-1975 ; AR(1)	(likely to be as in GDP)	(likely to be as in GDP)
		Break: 1982 (reverse series)	Chow-F at 1%		
		Colombia	**GDP**	**GDP per worker**	**GDP per capita**
		Starting sample	1900-2000	1920-2000	1920-2000
		AR model ; R2 ; SE	ARI(1,4) ; 0.165 ; 0.021	AR(1,6) ; 0.174 ; 0.022	AR(1,4) ; 0.1 ; 0.028
Stability analysis	*Recursive Least Squares*	Parameter constancy	Intability in 1929-32 Step change in 1950	Instability in 1928-32 Step change around 1980	Instability in 1929-32 Outlier in 1999
		Cusum of Squares	Max around 1950	Max around 1935	Max around 1955
		One-step Forecast (outliers)	1930-32, 1999	1934-35, 1981-82, 1999	1925, 1931, 1934, 1999
		Longest period of stability	1945-1978	1945-1978	1945-1978
		AR model ; R2 ; SE	ARI(1,4) ; 0.162 ; 0.0176	ARI(1) ; 0.16 ; 0.022	ARI(4) ; 0.26 ; 0.018
S. break tests	Chow tests	(period : model)	1900-1950 ; ARI(1,4)	1900-1950 ; ARI(1,4)	1900-1950 ; ARI(1,4)
		Break: 1929-1930	Chow-B at 1% ; Chow-F at 1%	Chow-B at 1% ; Chow-F at 1%	Chow-B at 1% ; Chow-F at 1%
			1945-1998 ; ARI(1,4)	1945-2000 ; ARI(1,4)	1945-2000 ; ARI(1,4)
		Break: 1980-82	Chow-B 1%	Chow-B at 1% ; Chow-F at 1%	no rejection of null
		Venezuela	**GDP**	**GDP per worker**	**GDP per capita**
		Starting sample	1900-2000	1900-2000	1900-2000
		AR model ; R2 ; SE	ARI(1,2) ; 0.09 ; 0.064	ARI(1,2) ; 0.1 ; 0.066	ARI(1,2) ; 0.09 ; 0.065
Stability analysis	*Recursive Least Squares*	Parameter constancy	step change around 1925	step change around 1925	step change around 1925
		Cusum of Squares	Outside interval, reaching max. in 1925 &1932	Outside interval, reaching max. in 1925 &1932	Outside interval, reaching max. in 1925 &1932
		One-step Forecast (outliers)	1914, 1925, 1931, 1989	1914, 1925, 1931, 1989	1914, 1925, 1931, 1989
		Longest period of stability	1946-1977	1946-1975	1946-1977
		AR model ; R2 ; SE	ARI(1,4) ; 0.25 ; 0.033	ARI(1,4) ; 0.29 ; 0.036	ARI(1,4) ; 0.22 ; 0.035
Str. break tests	Chow tests	(period : model)	1900-1929 ; ARI(1)	1900-1929 ; ARI(1)	1900-1929 ; ARI(1)
		Break: 1923	Chow-B at 1% ; Chow-F at 5%	Chow-B at 1% ; Chow-F at 2%	Chow-B at 1% ; Chow-F at 5%
			1925-1950 ; ARI(1)	1925-1950 ; ARI(1)	1925-1950 ; ARI(1)
		Break: 1930	no rejection/ too volatile	no rejection/ too volatile	no rejection/ too volatile
			1946-2000 ; ARI(1,5)	1946-2000 ; ARI(1,5)	1946-2000 ; ARI(1,5)
		Break: 1978	Chow-B at 5% ; Chow-F at 5%	Chow-B at 5%	Chow-B at 5% ; Chow-F at 5%

All series are integrated of order one at 1% of significant (ADF) exept GDP in Colombia and all series in Venezuela at 5%

Appendix II: Description of Variables

Panel Data Regressions: description of variables

Variables	original VAR *(mean, st. dev.)*	in logs LVAR=LOG(VAR) *(mean, st. dev.)*	lagged values LVAR = VAR(-6)	growth rate DVAR = LVAR - LVART1 *(mean, st. dev.)*	lagged growth D2VAR = LVART1 - LVART2
GDP per worker US$ ppp, 1970 prices	**GDPW** (1826 ; 1010)	LGDPW (7.33 ; 0.66)	LGDPWT1	dGDP (0.02 ; 0.02)	d2GDPW
Life expectancy at birth years	**LIFE**	LLIFE	LLIFET1	dLIFE	d2LIFE
Iliteracy rate %	**ILLIT**	LILLIT	LILLITT1	dILLIT	d2ILLIT
Investment share on GDP ratio, decade average	**IGDPAVG**		IGDPAVGT1		
Stock of physical capital US$ 1970 prices	**KAP**	LKAP	LKAPT1	dKAP	d2KAP
Total population (000s)	**POP**	LPOP	LPOPT1	dPOP	d2POP
Economically active population (000s)	**EAP**	LEAP	LEAPT1	dEAP	d2EAP
World demand import volume index, 1970 = 100	**WDEM**			WDEMg*	
Net barter terms of trade index, 1970=100	**NBTT**			NBTTg*	
Net barter terms of trade volatility standard deviations over a decade	**NBTTSD**				
Income terms of trade index, 1970=100	**ITT**			ITTg*	
US real interest rate %, decade average	**USRIRATED**				
Gov. spending as % of GDP ratio, decade average	**EXPGDPAVG**				
Budget deficit as % of GDP ratio, decade average	**GBSHAVG**	LGBSHAVG	LGBSHAVGT1		
Exports share on GDP (both in $) ratio based on current US$ values	**OPENX**	LOPENX	LOPENXT1	dOPENX	d2OPENX
Agricultural VA share on GDP ratio based on constant values	**AGRISH**	LAGRISH	LAGRISHT1	dAGRI	d2AGRI
Agricultural share of total EAP ratio	**AGEAPSH**	LAGEAPSH	LAGEAPSHT1	dAGEAP	d2AGEAP
Customs taxes share on total ratio based on current values	**CUTAXSH**	LCUTAXSH	LCUTAXSHT1	dCUTAX	d2CUTAX
Crisis of 1929	**CRISIS29**	dummy equal one circa 1930, zero otherwise			
Great Depression	**DEPRES30**	dummy equal one over the 1930s, zero otherwise			
Debt crisis of the 1980s	**DEBT80**	dummy equal one over the 1980s, zero otherwise			

(*) rate of growth are calculated as average annual growth over each decade

Typical values over the whole sample

variables	original values (VAR)			log transformation (LVAR)			rate of growth (DVAR)		
	Mean	Std. Dev.	Coeff. Var.	Mean	Std. Dev.	Coeff. Var.	Mean	Std. Dev.	Coeff. Var.
AGRISH	0.21	0.166	0.8	2.8	0.6	0.2	-0.01	0.016	-1.3
CUTAXSH	28.60	22.2	0.8	2.9	1.0	0.3	-0.03	0.054	-2.1
EAP	11106	14991	1.3	8.7	1.1	0.1	0.02	0.010	0.4
EXPGDPAVG	0.14	0.065	0.5						
GBSHAVG	-0.01	0.023	-1.6						
GDP	22567	32877	1.5	9.1	1.4	0.2	0.04	0.021	0.5
GDPW	1826	1010	0.6	7.3	0.7	0.1	0.02	0.019	1.2
GDPWUS	8847	5026	0.6	8.9	0.6	0.1	0.02	0.030	1.7
IGDPAVG	0.18	0.047	0.3						
ILLIT	31.87	21.1	0.7	3.2	0.8	0.3	-0.02	0.012	-0.6
INV	4506	7031	1.6						
ITT	3150	7081	2.2	7.1	1.4	0.2	0.04	0.052	1.3
KAP	51388	79933	1.6	9.9	1.4	0.1	0.04	0.026	0.7
LIFE	52.47	15.5	0.3	3.9	0.3	0.1	0.01	0.006	0.7
NBTT	125.5	97.3	0.8	4.6	0.6	0.1	0.001	0.043	55.0
NBTTSD	0.16	0.081	0.5						
OPENX	0.17	0.085	0.5	-1.9	0.5	-0.3	-0.003	0.038	-13.3
POP	29177	34880	1.2	9.7	1.0	0.1	0.02	0.008	0.4
USRIRATED	0.01	0.042	3.0						
WDEM	111	151	1.4	10.5	1.1	0.1	0.04	0.030	0.7

[Continued from inside front cover]

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