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Abstract

Analysis of new comparable series on output and employment between 1900 and 2000 for Argentina, Brazil, Chile, Colombia, Mexico, and Venezuela indicates that productivity growth was significantly higher and less volatile during the middle decades of the century than in the opening and closing decades. The first estimate of total factor productivity (TFP) growth for Latin America during the twentieth century as a whole, derived from the residuals of a skill-augmented production function, indicates that unembodied technical progress was low and that the accumulation of fixed and human capital accounted for almost all recorded economic progress. Sectoral disaggregation suggests that this factor accumulation was associated with increased levels of capital per worker during industrialization on the one hand; and with both out-migration from agriculture and the lagged consequences of a demographic transition on the other. The relatively low rates of human and physical capital accumulation in Latin America remain to be explained, although these are more likely to be associated with inadequate public provision of infrastructure and education than with the cycle of protection and liberalization as such.

JEL keywords: Aggregate Productivity and Growth, Agriculture, Manufacturing, Total Factor Productivity, Human Capital

JEL classification: O1, O4, N3, N5, N6

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PRODUCTIVITY GROWTH IN LATIN AMERICA DURING THE TWENTIETH CENTURY

1. Introduction

Productivity – the value added per head of the economically active population – more than quadrupled in Latin America during the twentieth century, yet it was still only one-eighth of the US level in 2000. Other regions such as Southern Europe and East Asia have made considerably more economic progress, particularly during the second half of the century. Alternative interpretations have set the agenda for economic historians and policy makers, but the lack of comparable long-run data series on productivity continue to beleaguer rigorous quantitative assessment.

Recent studies of the long-run economic growth of Latin America and of the world as a whole do include some aggregate output and population series for the region.[2] However, no single source so far has provided a quantitative basis for long-run productivity analysis. The quantitative literature on productivity in Latin America has thus concentrated on the post-WWII period and addressed aggregate rather than sectoral productivity.[3] New comparable estimates of output and employment from the Oxford Latin American Economic History Database (OxLAD) now permit an analysis of aggregate and sectoral productivity change in Latin America that encompasses the whole of the twentieth century.[4]

This paper focuses on Argentina, Brazil, Chile, Colombia, Mexico, and Venezuela (the 'LA6') because these countries account for three-quarters of population and output in Latin America. Figure 1 provides an overview of productivity trends for these six countries in 1970 PPP dollars and weighted by population: by this measure, Latin American productivity grew at 1.6 percent per annum between 1900 and 2000.[5] Three distinct periods can be distinguished within the century: 1900–36 with 1.5 percent per annum growth; 1937–77 with 2.6 percent; and 1978–2000 with *minus* 0.2 percent.[6] The first and third periods also experienced much higher volatility in annual productivity growth than the second. Thus productivity growth in the middle period can be

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[2] See Bulmer-Thomas (1994), Maddison (1995).

[3] Most recently, Fajnzylber and Lederman (2000) and Hofman (2000). Notable exceptions are Syrquin (1988) and Martin and Mitra (1999), but these studies of structural change have limited coverage – the immediate post-WWII decades in the former, and 1967–92 in the latter.

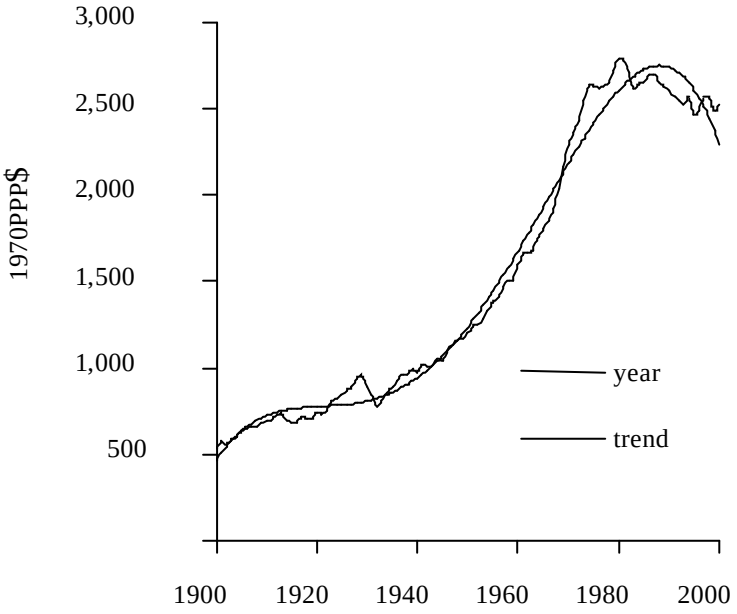
[4] Unless indicated otherwise, all data come from the OxLAD database, see Astorga, Bergés, and FitzGerald (2003a) (henceforth OxLAD).

[5] In the rest of Latin America (the 'LA13') productivity growth was only 1.0 percent between 1950 and 2000, compared to 1.5 in the LA6, see OxLAD.

[6] See Section 2 below for an explanation of how these periods are determined statistically.

unambiguously regarded as superior in terms of both level and stability in comparison to the opening and closing periods. These trends reflect a common pattern across the leading economies in the region.

FIGURE 1: PRODUCTIVITY (OUTPUT PER WORKER) IN THE LA6



Notes: 'year' gives the population-weighted mean of GDP per head of the economically active population (EAP) at 1970 constant PPP prices for that year in the LA6; 'trend' is the value of the fitted polynomial (see Section 2) for that year. *Source*: Appendix Table A.1.

This paper sets out our estimates of long-run productivity changes, and takes the first step towards their explanation. Section 2 discusses the sources and methods for our long-run productivity estimates, and the methodology for determining the principal 'growth periods'. A production function containing fixed capital and augmented labour is fitted to GDP at 1970 PPP dollars in Section 3; the residual ('error') term in the regression yields total factor productivity growth estimates. Section 4 explores the extent to which observed aggregate productivity changes can be explained by changing sectoral output and labour reallocation. Our main finding in Section 5 is that Latin American productivity change during the twentieth century is mainly explained by the uneven process of fixed and human capital accumulation. This view is supported by comparison with other regions of the world. Section 6 concludes with some propositions regarding the reasons for this low level of investment and skilling in Latin America during the twentieth century.

2. Estimating long-run productivity trends

The analysis of productivity change in Latin America during the twentieth century requires reliable estimates of gross domestic product (GDP). We have compiled comparable individual country GDP at constant 1970 prices from national and international sources; these in turn have been adjusted to reflect purchasing power parity (PPP) in order to permit cross-country comparisons[7] We have adopted the ECLAC (1978) adjustment coefficients because they are specifically constructed for the region and because their base year (1970) is the closest to the mid-century available. There is no means of constructing adjustment coefficients by, for example, each decade over the century. Because the discrepancy between PPP and market prices diminishes over time as a country industrialises and integrates with the world economy, we expect that our use of a single set of PPP correction factors for the whole century will underestimate real GDP for the earlier part of the century and hence overestimate long-run growth rates and intra-regional convergence. However, correction for this bias would only serve to reinforce our findings on productivity growth and convergence.

Our estimates of the Economically Active Population (EAP) are based on country census data.[8] Dividing GDP by EAP gives an estimate of average output per worker: a figure we term 'aggregate productivity'. The ideal measure of labour input in productivity estimates for developed countries is hours worked per year, since the average annual hours worked varies both between countries and over time, as do open unemployment rates (OECD 2001). However, data of this kind do not exist for Latin America even in recent decades, let alone for the century as a whole. Furthermore, the utility of this OECD definition for developing economies, with large 'informal' sectors of peasants, artisans and petty traders organized in household units, is questionable.

The resulting estimates of aggregate productivity are presented in Table A.1 of the Appendix, measured as 1970 PPP dollars per worker. Productivity levels clearly converged considerably within Latin America during the twentieth century: mainly because those for Argentina, Chile, and Colombia grew more slowly than those for Mexico, Brazil and Venezuela.[9] The slow growth of productivity in Argentina and Chile throughout the century, except in brief periods such as the 1960s in Argentina and the 1990s in Chile, is notable despite their 'head start' in terms of capital, labour and institutions. The superior performance of Mexico and Brazil without these initial endowments may thus be due to 'late-comers advantage' in technological absorption and transfer of labour out of traditional agriculture – in other words, extensive rather than intensive industrialization. These topics we take up again in Section 4.

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[7] See Appendix Table A.2. For a full discussion and a comparison of the ECLAC adjustment coefficients with those of other sources, see Astorga, Bergés, and FitzGerald (2003b).

[8] On the methodology, please refer to Astorga, Bergés, and FitzGerald (2003a).

[9] Productivity convergence within the region during the century is explored in a forthcoming paper.

As Figure 1 has shown, the productivity growth pattern reveals three distinct periods that differ markedly in both productivity growth rates and volatility.[10] These periods are determined by fitting a quartic time series trend to the annual series of population-weighted mean aggregate productivity for the LA6.[11] The points of inflexion are given by a change in sign of the second-order derivative of productivity with respect to time, and occur at 1936 and 1977.[12] These then define the periods of above- or below-average growth compared to the average for the century. This data-based method seems preferable to periodization based on presumed policy stances or political events, as is common in the literature. Consequently, long-run productivity in this paper is examined during three main periods: 1900–36, 1937–77, and 1978–2000.[13] Table 1 below summarizes the growth rates and volatility of output, labour force and productivity during the three periods identified above.

TABLE 1: PRODUCTIVITY TRENDS IN THE LA6, 1900–2000

LA6	*1900–1936*	*1937–1977*	*1978–2000*	*1900–2000*
Rate of growth (%)				
GDP	3.1	5.7	2.7	4.0
EAP	1.8	2.8	2.8	2.4
Productivity	1.5	2.5	–0.2	1.6
Volatility (%)				
GDP	5.9	3.6	3.8	4.5
EAP	1.2	1.6	1.8	1.5
Productivity	5.8	3.7	4.0	4.5

Notes: Volatility is defined as the intra-period standard deviation of productivity growth. *Source*: Table A.2 in the Appendix.

The 1900–36 period has a low productivity growth rate and greater volatility than for the century as a whole, which clearly reflects the impact of two world trade recessions in 1918 and 1929. Reliance on primary exports as the main engine of growth explains the instability, while much of the productivity growth itself probably reflects the exploitation of new natural resource reserves rather than increasing capitalization

[10] As measured by the standard deviation of annual productivity growth over the period.

[11] The fitted polynomial for productivity (using standard Excel software) in LA6 is:

$$y = -0.0003x^4 + 2.1673x^3 - 6316.2x^2 + 8E+06x - 4E+09; \quad R^2 = 0.9857.$$

Astorga, Bergés, and FitzGerald (forthcoming) estimate dynamic growth models for each country and test for structural breaks in the parameters.

[12] Income per capita shows a similar periodization, with inflection points occurring at 1939 and 1980; see Astorga, Bergés, and FitzGerald (2003b).

[13] The trend for the last period extends into the twenty-first century with zero or negative growth for at least the first quinquennium (World Bank, 2003). There is a case for extending the first period back into the 1890s (see Cardenas, Ocampo, and Thorp 2001) but this lies beyond the scope of our database.

or technical progress – a point we take up again in Section 5.[14] In contrast, the pace of productivity growth between 1937 and 1977 was substantially faster with lower volatility. It is difficult to avoid the conclusion that this clear improvement in productivity growth and stability was associated with the greater reliance on the domestic market as a demand source during the so-called 'import substitution' phase of state-led industrialization – despite subsequent critiques on grounds of micro-inefficiency.[15] Extensive economic reforms in the 1978–2000 period were designed to re-open the Latin American economies and increase growth – yet productivity *declined* sharply during this period and volatility nearly doubled that of the previous period.

As Figure 2 demonstrates, productivity in the LA6 failed to converge with the USA during the twentieth century, fluctuating at around 15 percent of the US level – both at 1970 PPP prices. There was some apparent narrowing of the productivity gap in the 1930s and again in the 1970s; but in neither case was this permanent. The first 'catch-up' was because the Great Depression had a far greater impact on the US than on Latin America, where expansionary fiscal and monetary policies sustained demand and tariffs saved foreign exchange.[16] But the gap widened again as the US economy entered the WWII boom. The second occurred in the later stages of Latin American state-led industrialization; but this too was soon eroded as economic growth rates declined and the US economy entered its technology-based boom towards the century's close. The productivity gap in 2000 was much the same as in 1900 in relative terms – and of course much greater in absolute terms. Figure 2 also shows a similar comparison with Spain, which might seem a more realistic comparator. At first sight there seems to be considerable convergence, at least until 1970. However, closer examination reveals that during our first period (1900–1936) there was no convergence, with LA6 productivity at about one-third the Spanish level. The ratio then rises rapidly to well over one-half but this is due as much to the consequences of civil war and autarky in Spain as to rapid industrialization in Latin America. Once successful liberalization and integration into the European Community took place in Spain, the productivity ratio falls back below that of the start of the century as Spanish productivity converges on that of the US. This comparison underlines the scale of the 'missed opportunity' of progressing from the initial stages of protected industrialization towards international competitiveness.

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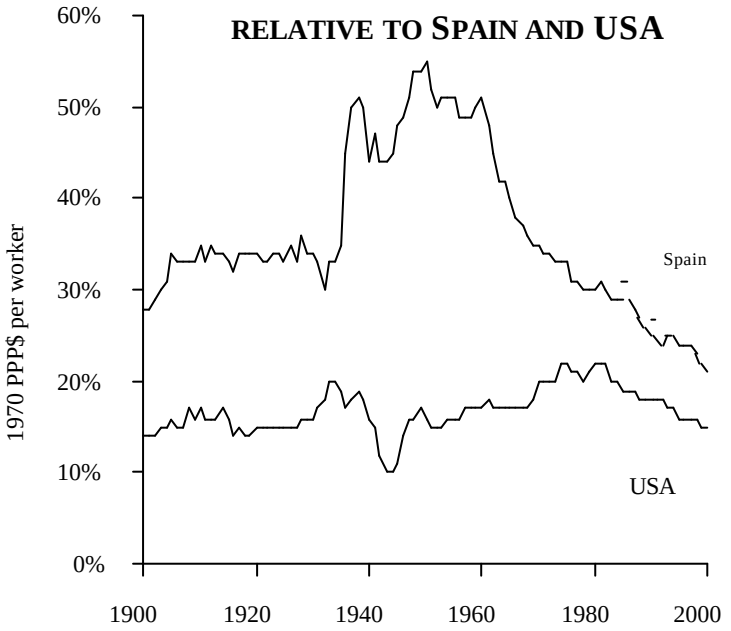
[14] Export growth in the LA6 during this period averaged 5.3 percent per annum, but was extremely volatile with a standard deviation of 16.2 percent, mainly due to world price fluctuations (see OxLAD). On terms of trade shocks as an obstacle to growth during this period see Cárdenas, Ocampo, and Thorp (2001), Chapter 1 and Thorp (1998), pp. 88–95.

[15] On import substitution as a model of accumulation in Latin America, see FitzGerald (2001), pp. 60–9.

[16] See Thorp (2000).

FIGURE 2: LA6 PRODUCTIVITY TRENDS RELATIVE TO SPAIN AND USA



Notes: US and Spanish GDP in 1970 PPP dollars calculated by applying index of GDP volume in constant PPP prices from Maddison (1995) to US GDP in 1970. *Sources*: LA6: OxLAD; Spain EAP: calculated from Prados de la Escosura (2003); Spain GDP: Maddison (1995) for 1900–94, IMF (2002) for 1995–2000; US GDP: Maddison (1995); US EAP: US Department of Commerce (1949), p. 65 for 1900–45 (figures for 1940 onwards based on 1940 census labour force (LF) concept; prior years converted from gainful worker (GW) concept to LF concept with 1940 ratio LF to GW of 0.98 reported in the same), ILO (2002) for 1950–2000 (10-yr intervals) and 1995, all other years interpolated by geometric mean.

3. Total Factor Productivity Growth

This section of the paper provides what we believe to be the first estimates of total factor productivity for Latin America over the whole twentieth century. A well-known debate continues over the extent to which output growth in developing countries should be attributed to the expanding stock of labour and capital on the one hand, and to technical progress (total factor productivity – TFP) on the other.[17] In perhaps the most comprehensive growth accounting study of the region to date, Hofmann (2000) finds that for 1950–96 the contribution of TFP to GDP growth in Latin America was lower than that for OECD countries and substantially less than that for the 'newly industrializing countries' of East Asia. Moreover, as we will discuss in Section 5 below, the rates of capital accumulation – both physical and human – were also inferior by international standards.

Because TFP growth cannot be observed directly, it is conventionally measured as the residual after the contribution of capital and labour to a production function has been accounted for – traditionally in a simple growth accounting framework (the so-called 'Solow residual').[18] More recently the residuals (i.e., error terms) from econometric estimation of the production function itself have been used. In principle, TFP should thus capture not only technical progress as such but also the acquisition and mastery of imported technology, positive (and negative) externalities from factor accumulation and even the contribution of institutional development to economic growth. However, the explanatory power of the productivity residual may be exaggerated if quality change in factor stocks (particularly embodied technology and improved education) are omitted from the production function. Moreover, utilization of productive capacity and unemployment levels can vary over time, leading to cyclical TFP estimates unsuitable for relatively short periods.

Table 2 below summarizes the main growth accounting exercises for Latin America to date. Because they use different periods, country groups and methodologies these estimates cannot be directly compared in detail; nonetheless they provide a broadly consistent picture. These authors find TFP growth to have been minimal over the second half of the century as a whole; it was positive during the first three decades, followed by decline in the 1980s and subsequent recovery in the early 1990s.

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[17] See for instance studies of the East Asian experience: Collins and Bosworth (1996), Krugman (1994), and Young (1994) all emphasize factor accumulation, while Dahlman, Ross-Larson, and Westphal (1987) and Romer (1993) find greater TFP growth, all from many of the same data sources.

[18] See Solow (1957). Conventionally, the elasticities in the Cobb-Douglas production function are derived from the observed labour share in national income.

TABLE 2: TOTAL FACTOR PRODUCTIVITY GROWTH ESTIMATES

	Countries in study (*no.*)	*TFP growth* (*percent*)		
Bruton (1967, 1995)	5	1.4 (1940–64)	–0.2 (1961–88)	
De Gregorio (1991)	12	1.3 (1950–70)	0.3 (1970–85)	
Elías (1992)	7	1.5 (1940–80)	–2.3 (1980–85)	
Fajnzylber & Lederman (2000)	18	0.7 (1950–79)	–1.7 (1980–89)	1.1 (1990–95)
Hofman (2000)–1	6	1.8 (1950–80)	–0.9 (1980–89)	1.8 (1989–94)
Hofman (2000)–2	6	0.8 (1950–80)	–1.8 (1980–89)	1.0 (1989–94)

Notes: Period intervals are given in parentheses. Hofman (2000)–1 refers to unaugmented TFP. Hofman (2000)–2 refers to doubly-augmented TFP. *Sources*: Bruton (1967, p. 1103), Bruton (1995, p. 15), De Gregorio (1991, p. 15), Elías (1992), Fajnzylber and Lederman (2000, p. 18), Hofman (2000, p. 113)

Fajnzylber and Lederman (2000), for instance, identify 1950–79 as a period of relatively high TFP growth in Latin America and attribute this to an increase in trade openness. In contrast, Solimano (1996) associates the high TFP growth in Argentina, Brazil, and Mexico in the 1940s and 1950s with import substitution and state-led industrialization. The poor TFP growth record of the 1980s is attributed by Fajnzylber and Lederman (2000) to the lack of economic liberalization and inadequate macroeconomic policies, rather than the exogenous shock of the debt crisis as such.[19] Improved TFP rates in the period 1990–95 are associated by most authors with market liberalization, even though much of the GDP growth was financed by the inflow of portfolio capital. Further, the series of financial crises in the latter part of the decade suggests this productivity recovery was more apparent than real. By contrast, Bruton (1967, 1995) argues that productivity growth from 1950–64 was relatively low by international standards and reflects a failure to adapt and modify diffused technologies. He attributes the subsequent decline in TFP rates to the exhaustion of the traditional development model in Latin America, well before the debt crisis. Finally, De Gregorio

[19] In a survey of studies on the effect of economic reform (measured by performance and policy-based indicators) on overall GDP, Easterly, Loayza, and Montiel (1997) find a generally positive effect. In the short- or even medium-run, however, growth effects are likely to be ambiguous: see Solimano (1996).

(1991) associates low TFP rates with periods of low GDP growth and argues this is evidence of poor macroeconomic policy and political instability affecting fixed investment and technical innovation as well as output itself.

Empirical studies of TFP rates in Latin America generally employ growth accounting methods rather than production functions.[20] The use of the wage share of GDP as the labour elasticity in a Cobb-Douglas production function is a serious cause for concern. First, the wage shares for Latin America reported by De Gregorio (1991) range from 0.30 to 0.58 for 1950–85. Second, the assumptions regarding competitive factor markets and constant returns to scale are not plausible. Third, the wage shares in the national accounts notoriously under-report the informal sector. Direct estimation of the production function would thus seem to be preferable.

The first step in our approach is thus to define an aggregate production function for each of the LA6 of the form:

$$Y_t = A_t K_t^{\,a} (h_t L_t)^b$$

where Y is GDP in 1970 PPP dollars in each year (t),[21] K is the stock of fixed capital calculated by the perpetual inventory method, and L is the stock of labour, given by the economically active population, adjusted for quality changes by the literacy rate of the population (h).[22] A is then total factor productivity (TFP).

Data on the stock of capital for Latin American countries is not available from official sources so we have estimated it from annual figures for gross fixed capital accumulation by the 'perpetual inventory' method.[23] Hofman (2000) seeks to incorporate quality changes by estimating the average age of the stock to reflect 'vintage' effects in his estimates of fixed capital stocks for Latin America for 1950–96. As disaggregated data on machinery, equipment, and residential and non-residential structures are not readily available for the whole century, we were not able to do this. The problem of capacity utilization – due to insufficient domestic demand or import constraints –

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[20] In growth accounting, TFP growth (a) for a given period is simply defined as

$$a = y - [(1-b)k + bl]$$

for observed rates of growth of GDP (y), capital stock (k), labour force (l), and a weighting factor (b) which is the share of labour in national income.

[21] We opted not to adjust for recession years, when capital and labour are under-utilized, as there is no satisfactory means of identifying the source of depressed demand: see North (1993), David and Wright (1999), Crafts and Mills (2001), and Easterly and Levine (2001).

[22] Labour quality and quantity are conventionally taken to be perfect substitutes: see Barro and Sala-i-Martín (1995).

[23] Pioneered by Goldsmith (1951). The capital stock is estimated as the sum of past net investment flows:

$$K_t = K_{t-1}(1-d) + I_t$$

where (I_t) is gross fixed capital formation and (d) is the annual depreciation rate. Opening capital stock (K_0) is estimated by applying a capital-output ratio to GDP, which is then adjusted recursively in 1900.

has been treated by Bruton (1967) as a key factor in explaining productivity growth, whereas Lefort and Solimano (1994) and Fajnzylber and Lederman (2000) simply disregard years of negative GDP growth. In our case we have measured TFP over relatively long periods so the cyclical effects should be less.

Nonetheless, TFP estimates are still sensitive to assumptions made regarding the initial level of capital stock, and the depreciation rate used (Pritchett 1996).[24]

A significant innovation in this paper is the use of augmented labour in long-run historical data. Human capital stock is generally incorporated into econometric growth estimations for developed countries by using indicators of educational attainment or at least average years of schooling (Barro and Lee, 2000). For developing countries without such data, the proportion of children enrolled in secondary school is the usual replacement (Mankiw, Romer, and Weil, 1992). As even the latter statistic does not exist for Latin America for the whole century, we follow Romer (1990) and use literacy as our metric for the quality of the labour force.[25]

The production function in log-linear form is estimated by OLS regression of the two factor stocks on GDP:[26]

$$\log Y_t = \log A_t + \alpha \log K_t + \beta \log(hL_t)$$

Rearranging:

$$\log A_t = \log Y_t - (\alpha \log K_t + \beta \log(hL_t))$$

This yields the two factor stock coefficients (α and ß) directly (shown in Table 3 below), while the goodness of fit captures the extent to which GDP is 'explained' by changes in these stocks. Substituting the factor stock coefficients from the regression results back into the equation and first-differencing yields the TFP growth rates in Table 4 below.

[24] In our case, 3.0 and 0.05 respectively.

[25] The proportion of the Latin American population classed as literate in 1900 was 33 percent; by 2000, literacy rose to 89 percent of the population. The implication is that by 2000, the workforce was nearly three times as skilled as it had been in 1900, and also far healthier: life expectancy experienced a 41-year increase during the century to 70 years by 2000. See Table A.5 in the Appendix, and Astorga, Bergés, and FitzGerald (2003b) on trends in living standards.

[26] In contrast to De Gregorio (1991) and Fajnzylber and Lederman (2000), our approach makes no a priori assumptions regarding returns to scale.

TABLE 3: COEFFICIENTS FROM THE FITTED PRODUCTION FUNCTIONS, 1900–2000

	Capital (a)	*Labour* (b)	*Returns to Scale* ($a+b$)
Argentina	0.464	0.633	1.097
Brazil	0.233	0.980	1.213
Chile	0.498	0.725	1.223
Colombia	0.962	0.210	1.171
Mexico	0.264	0.819	1.083
Venezuela	0.972	0.000	0.972
LA6	0.390	0.761	1.151

Notes: LA6 is population-weighted mean.
Source: Appendix Table A.3

The full results are set out in Appendix Table A.3. In all six cases the regression coefficients indicate that the two factor stocks explain all but a few percent of total GDP during the period. This means that the net contribution of TFP growth for the century must be quite small. As Appendix Table A.3 shows, the DW statistics are all low due to autocorrelation between the residuals, as might be expected for TFP change, and the F-statistics are all reassuringly high. For all cases, the sum of the capital and (augmented) labour coefficients is close to unity – indicating few if any overall scale economies: this is consistent with convention but nonetheless surprising over the long run.[27] The capital and (augmented) labour coefficients seem to fall within the conventional range for Argentina and Chile. However those for Colombia and Venezuela show very high coefficients for capital and correspondingly low ones for labour: in the case of Venezuela this can be explained by resource-led growth, but this is not so likely for Colombia. The high coefficient for labour and the low coefficient for capital in the Brazilian case may imply that capital has not been efficiently used while skilled labour has promoted growth, while in that of Mexico this may reflect the close association with the US economy where capital is cheap and skills are highly valued.

Table 4 below presents our results for TFP growth for the three productivity growth periods identified above. TFP growth averaged less than one-tenth of one percent per annum between 1900 and 2000, and thus accounted for just 2 percent of the overall

[27] Long-run estimates for developed countries find returns to scale that are roughly constant, with a capital coefficient of the order of 0.4 (see Fischer 1993, Nehru and Dareshwar 1993, Marfán and Bosworth 1994); but Collins and Bosworth (1996, p. 155) suggest that the elasticity of capital should be higher in developing countries, and endogenous growth theory implies that increasing returns to scale are expected too.

increase in productivity during the century.[28] Further, the TFP growth rate clearly declined throughout the century. On the one hand, the more rapid process of capital accumulation during 1937–77 (see Section 5 below) was not accompanied by a rise in TFP growth as would be suggested by the 'embodiment' hypothesis.[29] On the other hand, the economic reforms saw a decline in TFP from 1978 onwards in every country except Chile. The relatively rapid apparent TFP growth in the first third of the century is almost certainly related to the reliance on natural resource exports for growth, endowments of which are not part of our production function. Unfortunately, we have no means of measuring the resource stock in a comparable manner to capital and labour over time and between countries.[30]

TABLE 4: PERIOD AVERAGES OF TFP GROWTH (PERCENT)

	TFP growth			
	1900–2000	*1900–1936*	*1937–1977*	*1978–2000*
Argentina	0.15	0.13	0.39	–0.23
Brazil	0.06	0.68	0.59	–1.87
Chile	0.33	0.24	0.26	0.58
Colombia	–0.16	0.60	0.06	–1.76
Mexico	0.10	0.50	0.29	–0.86
Venezuela	0.31	1.41	–0.17	–0.54
LA6	0.08	0.56	0.39	–1.26

Notes: 'LA6' is the population-weighted mean. Growth rates are arithmetic rather than geometric averages because of the problems raised by taking an even root of a negative number. *Source*: see Table A.4 in the Appendix.

Whether a country is able to achieve rapid productivity growth through the diffusion of technology will depend in great measure upon its stage of economic development.[31] We would expect countries with higher incomes and more advanced institutions at the outset of the century, such as Chile and Argentina, to experience higher

[28] The 'unaugmented' form of our model (when quality changes in labour are excluded) shows TFP growth of 1.1 percent per annum. Moreover, our estimates may underestimate TFP to the extent that endogenous innovation is embodied in new types of capital, since its effects would be felt through an 'excessive' capital contribution (a), see Barro (1999).

[29] See Scott (1991).

[30] Maddison (1995), for instance, proxies for natural resource endowments with land area. This does not seem plausible, given that this measure is time-invariant, does not reflect mining resources, and does not even distinguish between arable and otherwise unproductive land.

[31] See Collins and Bosworth (1996).

TFP growth due to their ability to seize the convergence ('catch up') benefits of technology transfer from industrialised countries, and 'late starters', such as Mexico and Brazil, to be more dependent on higher rates of factor accumulation.[32] Surprisingly, this does not seem to be the case for Latin America during the twentieth century. The contribution of TFP growth over the century as a whole is highest in Chile, Venezuela, Argentina and Mexico, and lowest in Colombia, while contribution of factor accumulation is no lower for the early starters. At the turn of the century, Brazil, Argentina, and Mexico enjoyed the highest absolute productivity (see Appendix Table A.1), with Colombia, Venezuela, and Chile still lagging behind; by 2000, Chile and Argentina, and Mexico and Brazil, had traded places but otherwise the ranking remained constant. Moreover, for all countries TFP growth is higher during the stage of state-led industrialization between 1937 and 1977 than in the subsequent 'reform' period except in the case of Chile.

Factor accumulation – fixed capital and skilled labour – must therefore be the main source of growth in all six countries during the twentieth century. The uniform pattern of faster productivity growth in the middle period must therefore be due to higher rates of factor accumulation during those years. Nonetheless, the reallocation of the labour force between sectors – particularly from agriculture to industry – may also have played a significant role. It is to this issue that we now turn.

[32] See Grossman and Helpman (1994). The importance of institutional quality and efficiency has been the focus of North and Thomas (1973), Abramovitz (1986), Keefer and Knack (1995), Mauro (1995), Hall and Jones (1999), and Rodrik (2001).

4. Sectoral Productivity and Structural Change

An important aspect of economic development is the shift of labour from low- to high-productivity sectors – typically from agriculture to industry. We have sufficient data on the labour force and value added in agriculture and manufacturing for the LA6 to permit estimates of century-wide sectoral productivity, although we cannot measure sectoral human or physical capital stock. Although services have accounted for at least half of GDP from 1945 onwards, we do not attempt to measure productivity in the tertiary sector.[33] The reason for this is because 'output' in government has little economic meaning, while petty commerce and services act as 'labour sponges' with a large part of their workforce effectively underemployed.[34] As discussed above, mining presents a similar problem, in that changes in measured output per worker reflect the changing discovery and exploitation of resource endowments (and also shifting international demand patterns) rather than labour productivity itself.

Our measure of sectoral productivity (P_{jt}) in sector j in year t is thus aggregate labour productivity (P_{Tt}) as defined in Section 2 above, multiplied by the share of that sector in GDP (X_{jt}) at current prices and divided by its share in the EAP (Z_{jt}), yielding a figure in 1970 PPP dollars in year (t):

$$P_{jt} = P_{Tt} \frac{X_{jt}}{Z_{jt}}$$

The results are shown in Table 5 below. Output, employment, and productivity in manufacturing grew faster than in agriculture for all countries save Brazil and Venezuela. Surprisingly, the inter-sectoral productivity gap is not large: on average, productivity growth in agriculture reached more than three-quarters of that in manufacturing, while the variance in industrial productivity is slightly greater than in agriculture. This gap is widest in Mexico and narrowest in Chile and Colombia, but the pattern seems contrary to expectations. There are two possible explanations: first, much of the apparent increase in agricultural productivity is in fact the result of rural-to-urban migration of surplus rural labour; and second, technological transfer into 'modern' agriculture (from the US in particular) has been less difficult than the more complex technological learning in manufacturing, which has required new forms of corporate organization as well as imported equipment and labour skilling.

[33] ECLAC (1978).

[34] For further discussion, see FitzGerald (1993, Chapter 5), which models productivity (and thus income) in the informal sector through the impact of internal migration on labour supply.

TABLE 5: SECTORAL PRODUCTIVITY GROWTH RATES 1900–2000

	Agriculture			*Manufacturing*		
	Output	Employment	Productivity	Output	Employment	Productivity
LA6	2.9	1.4	1.7	4.9	3.0	1.8
Argentina	2.3	0.8	1.5	3.5	1.6	1.9
Brazil	3.4	1.4	2.0	5.1	3.9	1.1
Chile	2.5	0.8	1.7	3.7	1.7	2.0
Colombia	2.6	0.7	1.9	4.4	2.3	2.0
Mexico	2.3	1.2	1.0	5.4	2.4	2.9
Venezuela	3.6	1.2	2.3	5.3	3.2	2.0

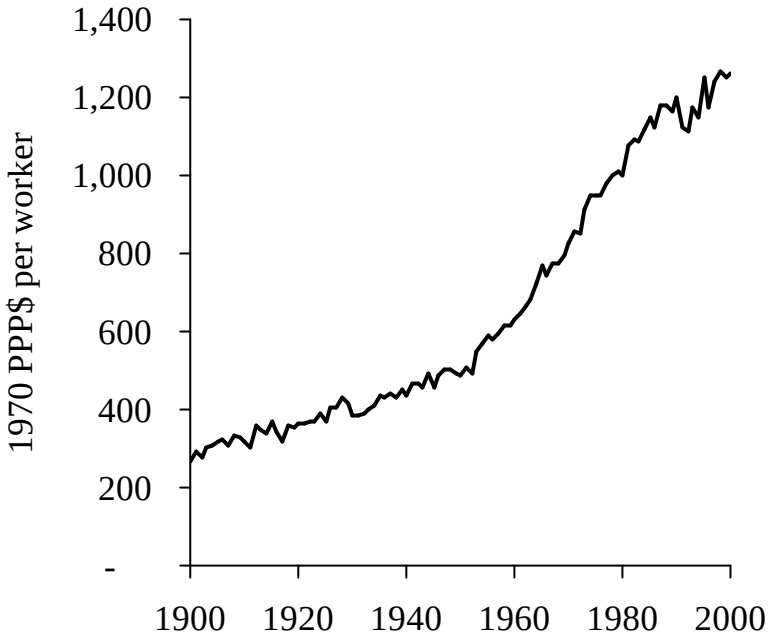
Notes: 'LA6' is population-weighted mean.
Sources: Appendix Table A.7.

The greatest improvement in agricultural and manufacturing productivity in the LA6 occurred during 1937–77, with growth rates of 1.7 percent and 3.2 percent, respectively. Agricultural productivity continued to grow after 1977 in Brazil and Chile, but declined in Argentina and Colombia, and more dramatically in Mexico and Venezuela. Overall, however, agricultural productivity seems to have increased relatively rapidly and steadily between the mid-1950s and the mid-1980s, albeit due to labour shedding.[35]

The pattern of manufacturing productivity growth is similar, with more rapid growth during 1937–77 followed by deceleration in all countries, and even decreases in Colombia and Venezuela. As might be expected, manufacturing shows a stronger tendency towards sectoral convergence in the region than agriculture: the dispersion of agricultural productivity between LA6 countries fell by 12 percent over the century, compared to a 26 percent fall manufacturing dispersion – see Appendix Table A.7.

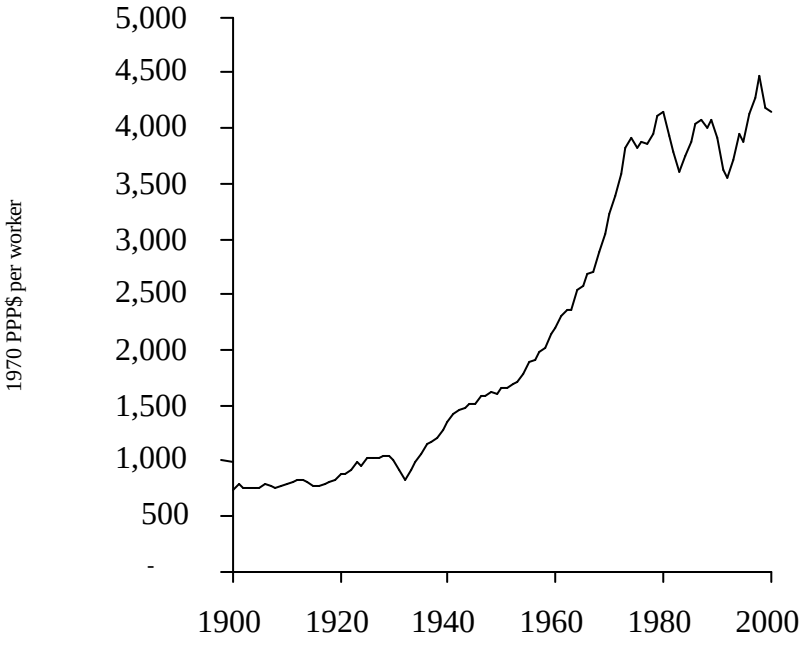
[35] Agricultural productivity growth is generally overlooked in the literature. Martin and Mitra (1999) on TFP growth in agriculture and manufacturing is a notable exception. They find that productivity growth rates in agricultural are relatively high, and that in many countries they were higher than those in manufacturing. They attribute this finding to faster international dissemination of innovations in agriculture than in manufacturing.

FIGURE 3: AGRICULTURAL PRODUCTIVITY IN LATIN AMERICA



Source: Table A.7

FIGURE 4: MANUFACTURING PRODUCTIVITY IN LATIN AMERICA



Source: Table A.7

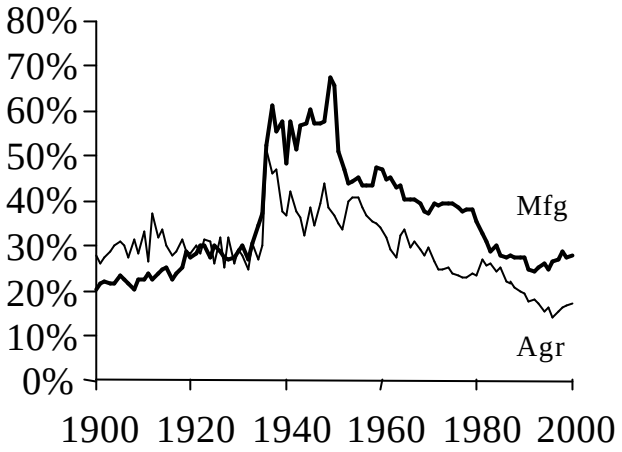
These patterns of sectoral productivity change were underpinned by changes in the composition of national output and employment. As Table A.5 in the Appendix shows, agricultural employment in the LA6 declined from 69 percent of the labour force in 1900 to 24 percent by 2000, experiencing its steepest fall during 1936–77. Venezuela and Colombia saw the greatest decrease in share, followed by Argentina. However, significant rural-to-urban migration only began in the 1950s: the absolute size of the labour force in agriculture in the LA6 did not start to decline until the 1980s.[36] The labour shedding in agriculture has clearly had a positive effect on sectoral productivity by simply draining off underemployed labour held on family farms. In contrast, the absolute size of the economically active population in manufacturing grew by an average of 3 percent per annum from 1900–2000, and by as much as 5 percent in the 1940s, declining only from the early 1980s onwards. The share of manufacturing in total EAP for the LA6 peaked in the mid-1970s, with Argentina and Chile experiencing the greatest increases. Despite increasing absolute levels of manufacturing employment, however, its share of EAP declined steadily in the last quarter of the twentieth century to levels last seen in the late 1940s. This decline appears to be mainly due to the impact of trade liberalization on labour-intensive small and medium manufacturing firms.

Table A.5 also illustrates the sharp fall in the agriculture share of output from 27 percent in 1900 to less than 10 percent in 2000, with the middle decades seeing the greatest decline. In contrast, the manufacturing share of output followed a similar pattern to that of the employment share, rising from 9 percent in 1900 to 27 percent by 1977 before dropping to 27 percent in 2000. The share of manufacturing in total output declined after the 1970s for all countries save Mexico and Venezuela, Argentina and Brazil experiencing the greatest decline.

A comparison of trends in manufacturing and agricultural productivity as between the LA6 and Spain is illuminating. As Figure 5 demonstrates, between 1900 and 1935 LA6 manufacturing and agricultural productivity were both about one-fifth of the Spanish level. The gains over the subsequent two decades to about one-half of Spanish sectoral productivity levels were not only the result of improvements in Latin America, but also of the consequences of war for the Spanish economy. Of most concern, however, is the steady divergence between Spain and the LA6 during the second half of the century so that by 2000 the sectoral productivity gap in manufacturing was similar to its value in 1900 and in agriculture was considerably greater – a broad indicator of the foregone opportunities for economic development in Latin America since WWII.

[36] This rural exodus occurred much later in Mexico, probably because it embarked upon large-scale land reform relatively early in the twentieth century following the 1910–20 Revolution.

FIGURE 5: LONG-RUN TRENDS IN LA6 SECTORAL PRODUCTIVITY RELATIVE TO SPAIN (PERCENT)



Sources: Spain: Sectoral productivity calculated from Prados de la Escosura (2003); LA6: OxLAD.

In order to synthesize these complex shifts in output and employment we construct a simple expositional framework derived from standard economic development theory, which is summarized in Table 6 below. Growth at an early stage of industrialization is generally understood to be 'extensive' in the sense that both output and employment expand rapidly while productivity grows slowly. This is followed by an 'intensive' stage where output increases more than employment, with a rapid rise in productivity. This crucial transformation is usually associated with deeper technological change and with emerging labour scarcities. When this desirable second stage is not achieved, undesirable states of 'stagnation' (low employment and output growth with little productivity change) or even 'regression' (output growth less than that of employment, so productivity falls) can result. Examining productivity change alone without considering the output and employment components separately risks confusing extensive growth with stagnation, therefore.

TABLE 6: CHARACTERIZATION OF SECTORAL GROWTH

	Growth relative to long run	
	Output	*Employment*
Extensive (EXT)	Higher	Higher
Intensive (INT)	Higher	Lower
Stagnation (STA)	Lower	Lower
Regression (REG)	Lower	Higher

Source: See text.

The model is applied in Table 7 below. The evidence for agriculture is mixed: growth was extensive in most of the LA6 in the first and second periods, with four

countries (Brazil, Chile, Colombia, and Mexico[37]) showing an improvement in the second period. In the third period, however, growth was either stagnant or regressive in all countries save Chile – the only country to see sustained progress over the course of the twentieth century as its agricultural sector shifted from regressive, to extensive, and finally intensive, growth. Stagnation in Brazil and Argentina in this period was due to continued urban migration.

In contrast, growth trends in manufacturing present a more consistent picture, with the anticipated extensive growth phases occurring in all countries from 1937–77 after a generally stagnationary first period. As discussed below, this was accompanied by the highest rates of growth in both fixed and human capital. However, there is clearly a failure to attain intensive growth in the 1978–2000 period. Half of our countries experienced stagnation and the other half experienced regression. Possible explanations include the adverse effects of external shocks, financial crisis, and fiscal retrenchment on demand, as well as the negative impact of trade liberalization and economic reform on industrial employment, particularly in the less competitive small and medium firms.

TABLE 7: CHARACTERIZATION OF SECTORAL GROWTH PERIODS IN LATIN AMERICA

	Agriculture			*Manufacturing*		
	1900–1936	*1937–1977*	*1978–2000*	*1900–1936*	*1937–1977*	*1978–2000*
LA6	REG	INT	STA	STA	EXT	STA
Argentina	EXT	STA	STA	EXT	EXT	STA
Brazil	EXT	EXT	STA	REG	EXT	STA
Chile	REG	EXT	INT	STA	EXT	REG
Colombia	REG	INT	REG	STA	EXT	REG
Mexico	STA	EXT	REG	STA	EXT	REG
Venezuela	EXT	STA	REG	STA	EXT	STA

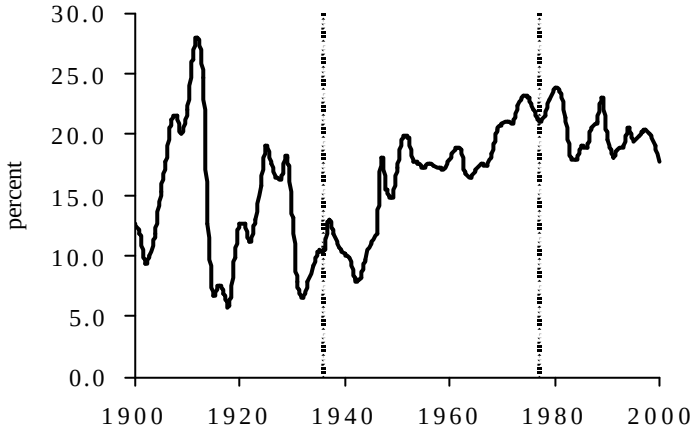
Source: See text.

[37] In Mexico, extensive growth in agriculture was delayed until after the Revolution.

5. Factor accumulation and productivity growth

Investment is essential for the generation of new capital stock and embodiment of new technologies, but investment rates have been relatively low throughout the century in Latin America, as Figure 6 indicates. In fact gross fixed capital formation averaged only 17 percent of GDP, about half the ratio experienced by the East Asian 'tigers' in recent decades.[38] However the investment rate did rise considerably between the first and second halves of the century, while its volatility decreased. The explanation may relate to the reduced reliance on fluctuating export revenue (uncertainty depresses investment) on the one hand, and the development of domestic financial institutions on the other.[39] However, although industrialization and rapid productivity growth get under way from 1937, the investment rate only rises substantially after 1950. This may be due to excess domestic industrial capacity being absorbed during the Great Depression and WWII as Latin America shifted into import substitutes, with new capacity only needed later.[40] Moreover, the investment rate seems to have been maintained after 1978 – albeit with a trough after the 1982 debt crisis – but without significant impact on increases in capital stock per worker due to accelerated EAP growth.

FIGURE 6: INVESTMENT SHARE OF GDP IN LATIN AMERICA



Note: Ratio of gross fixed capital formation to GDP for the LA6. *Source*: Appendix Table A.8

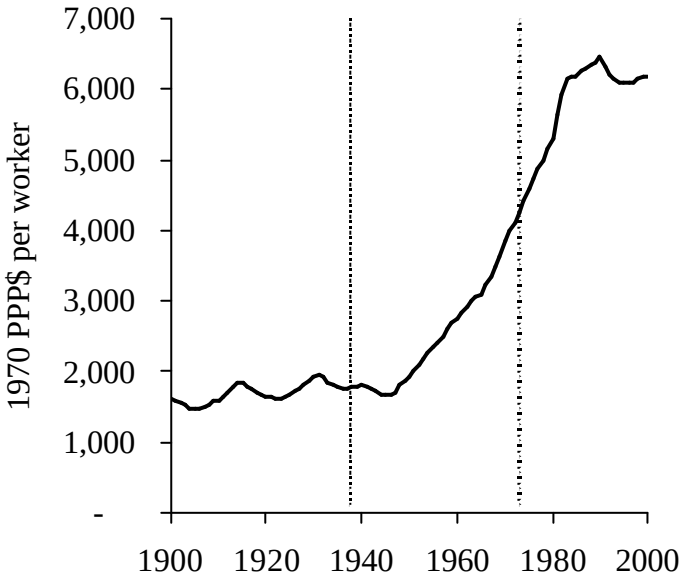
[38] Gross fixed capital formation in South Korea, Hong Kong, Singapore, and Japan averaged 30 percent of GDP between 1960 and 2000, compared to 20 percent in Latin America (World Bank 2001).

[39] However, the underestimation of investment in the historical national accounts before 1950 is also a possibility.

[40] On the impact of the Great Depression on capital formation in Latin America, see FitzGerald (2000).

Despite a 3.8 percent per annum increase in the capital stock in the LA6 between 1900 and 2000, a workforce growth of 2.4 percent implies a long-run growth rate of capital stock per worker of only 1.4 percent. This statistic lies at the core of the problem of economic development in Latin America during the twentieth century. As Figure 7 indicates, capital stock per worker stagnated between 1900 and 1950, but then rose rapidly – tripling between 1950 and 1980 – only to revert to stagnation after the debt crisis of 1982. Chile shows a decline of capital stock per worker between 1970 and 1985, as might be expected, but rapid growth thereafter. Mexico sustained a rising trend from 1940 until the crisis of the mid-1990s. However, Colombia, Argentina, and Brazil show no increase between 1980 and 2000 at all, while Venezuela shows a marked decline. This seems to be consistent with the trends in aggregate productivity growth presented in Section 2 and with the pattern of industrialization discussed in Section 4, once allowance is made for the better use of installed capacity in the 1940s. However, it is surprising that despite the tripling of capital stock per worker between 1950 and 1980, there does not seem to have been any significant spillover into TFP growth during those decades as measured in Section 3.

FIGURE 7: CAPITAL STOCK PER WORKER IN LATIN AMERICA



Sources: Population-weighted mean for LA6.
See Section 3 for an explanation of the sources and methods for capital stock and labour force estimates. Appendix Tables.

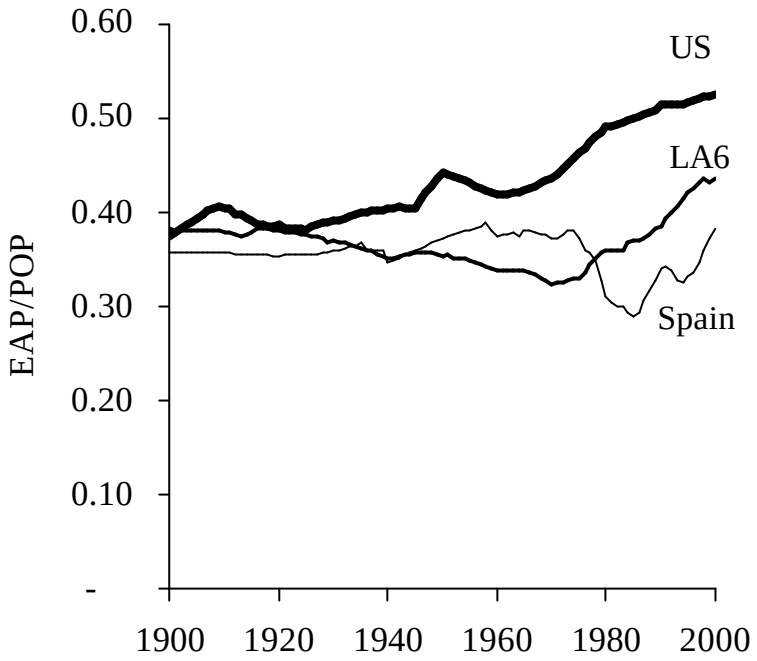
Nonetheless, the relatively rapid increase in the labour force combined with the relatively low rate of capital accumulation may help explain declining aggregate productivity (and TFP) growth through the century as a whole. The workforce in Latin America itself grew in response to population expansion and changes in participation rates, and skill levels improved as a result of the spread of schooling. Population growth in Latin America during the twentieth century reflects a familiar demographic transition, rising mid-century with the fall in mortality rates, and declining towards the end with the fall in birth rates.[41] The sudden increase in participation rates (or decrease in the dependency ratio) in the mid-1970s is evident in Figure 7, particularly when compared with the more 'regular' patterns for the US and Spain.

This increase was partly due to sociological changes, such as the increase in female work force participation, but also to the lagged effect of declining infant mortality during the 1940s and 1950s. Data on the economically active population (EAP) for the post-1950 period from the ILO show a complementary increase in workforce and population rates until the 1960s. The EAP subsequently grew by 73 percent between 1963 and 1980, compared to 59 percent growth in population in the same period; and then accelerated further as the EAP increased by 61 percent between 1980 and 1998 compared to 36 percent for population. However, this pattern of increasing activity rates starts at different dates in each country: as early as 1960 in Brazil; around 1970 in Chile, Colombia, Venezuela, and Mexico; and as late as 1990 in Argentina. This increase appears to be due largely in part to the demographic transition, as the better health and urbanization of the 1940s onwards worked through birth rates into greater workforce participation. But the entry of women into the workforce as social structures and labour requirements changed was clearly important, with the greatest increases in the female participation rate occurring in Mexico, Venezuela, Brazil, and Colombia, rather than the more 'socially advanced' Chile and Argentina.[42] However, whereas the increase in population and workforce may have exerted a positive demand effect on the creation and expansion of domestic markets in the first half of the century, in the second half the problem was one of productively absorbing the growing labour force – the failure to do so exacerbating social inequality.

[41] On the demographic transition in Latin America, see del Popolo (2001). Astorga, Bergés, and FitzGerald (2003b) discuss the welfare implications of these trends.

[42] See Appendix Table A.6. This increase in female participation may be due in part to improved recording, particularly as women's participation in agriculture and in family firms has traditionally been high but under-reported in censuses.

FIGURE 8: RELATIONSHIP BETWEEN WORKFORCE (EAP) AND POPULATION (POP)



Sources: LA6: OxLAD; Spain and US EAP:
see Figure 2; US population: Maddison (1995);
Spain population: calculated from Prados de la Escosura (2003).

6. Conclusions

The main finding of this paper is the marked sinusoidal ('S-shaped') curve of productivity growth in Latin America during the twentieth century, which falls statistically into three distinct periods: 1900–36; 1937–77; and 1978–2000. The first and third periods are distinguished by low productivity growth and high volatility; and high growth and low volatility in the second period. This pattern is repeated in all the six major economies of the region, albeit with some differences in timing. This pattern is suggestive: the natural export-led model of the first decades did very little for productivity; nor (despite expectations) did the post-1980s reforms. The only sustained progress was in the middle period of state-led industrialization.

Latin America in the twentieth century was characterised by very low rates of total factor productivity (TFP) growth, which actually declined over the century, – although higher initial levels may well be due to resource rents not being accounted for in our model.[43] It seems clear that the key to understanding productivity growth in Latin America during the twentieth century is factor accumulation: fixed capital and human capital. This also appears to be the case for East Asia.[44]

Productivity growth was thus largely dependent upon the highly erratic process of factor accumulation. The labour force not only became more skilled over the course of the century as literacy spread and the population became urbanized, but it also grew very rapidly indeed, especially in the second half as the benefits of earlier health improvements worked their way through the demographic structure. As a result, job-creation remained a persistent problem throughout the century. Investment rates appear never to have reached even half of those of the East Asian economies during their rapid industrialization phase. Capital stock per worker was more or less static in 1900–36, which explains the low rate of productivity growth once resource rents are discounted, and increased rapidly in 1937–77 with the increase in both public and private investment rates. This again explains much of productivity growth, especially in manufacturing. Its slow increase after 1978 (the only exception being Chile) appears to have been due to the failure of the expected private investment response and the expected increased efficiency in the use of the capital stock to materialize following economic liberalization.

Our estimates of industrial productivity paint a picture of a relatively successful 'extensive' industrialization process during 1936–77 and poor growth after 1978. Productivity gains in the closing decades of the century were largely based on labour shedding rather than on technology: only Mexico was able to move on from import-substitution into manufactured exports as an engine of growth; the rest of the LA6 found this transformation much more difficult and at the century's close they were

[43] Exogenous influences on productivity change (such as the positive effect of foreign investment and trade integration and the negative impact of external shocks) are also neglected, but will be considered by the authors in a forthcoming paper.

[44] See Krugman (1994) and Young (1994, 1995).

still basically exporters of raw and processed primary products. Indeed, agricultural productivity rose steadily throughout the century at a rate comparable to that of manufacturing, although, with the exception of Chile and Argentina, much of this apparent productivity growth was in fact the result of rural-to-urban migration of surplus labour.

If we can characterize the 1937–77 period as containing a relatively successful process of 'extensive' growth based on factor accumulation and led by public investment in economic infrastructure and human capital (health and education), the issue then arises as to what brought it to an end and why it was not followed by an 'intensive' stage – except possibly in Mexico. Many authors attribute this failure to intrinsic problems of the industrialization model itself, particularly protectionist pressures from domestic industry and thus inability to compete on the export market on the one hand and excessive labour costs sustained by a politically mobilized industrial workforce on the other.[45] Abandonment of the model did not lead to increased productivity growth as we have seen – indeed those industrial sectors that have become competitive internationally are generally rooted in a previous import-substitution stage.[46] In fact most of the LA6 (with the exception of Venezuela) had begun to shift industrial promotion policies towards exports in the early 1970s: the determinant of the radical strategy change was undoubtedly the debt crisis of the early 1980s, that not only depressed productive investment but also led to the sale of state assets to foreign investors. The crisis was undoubtedly fiscal in origin and led directly to subsequent waves of privatization, debt and currency weakness.[47] The failure to resolve the fiscal issue and engage in the required levels of public provision of infrastructure and education is a problem that characterizes the whole century. This is not simply a matter of 'bad policy' – rather its roots are to be found in the lack of social consensus and the degree of income inequality in the region. The shift towards liberal democracy throughout Latin America during the last quarter of the twentieth century was a welcome development but did little to reduce social inequality or increase macroeconomic stability – and thus improve the prospects for factor accumulation and sustainable productivity growth.

[45] On the impact of institutional constraints and populist economic policies on the state-led industrialization model, see Katz and Kosacoff (2001) and Dornbusch and Edwards (1991), respectively.

[46] See Teitel and Thoumi (1986).

[47] See FitzGerald (2001).

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8. Appendix

TABLE A.1: OUTPUT PER WORKER

Year	*LA6*	*Argentina*	*Brazil*	*Chile*	*Colombia*	*Mexico*	*Vene-zuela*
1900	536	1,161	318	725	440	625	399
1910	692	1,603	385	930	402	822	397
1920	744	1,500	469	964	359	950	484
1930	893	1,873	491	1,524	412	976	1,256
1940	944	1,890	572	1,433	674	1,132	1,264
1950	1,237	1,982	675	1,520	1,083	1,563	2,020
1960	1,592	2,398	994	2,019	1,376	2,012	3,044
1970	2,293	3,099	1,308	2,718	1,806	3,468	4,075
1980	2,786	3,595	2,117	2,813	2,364	3,606	3,575
1990	2,599	2,889	1,842	2,846	2,187	3,900	2,708
2000	2,295	3,505	1,899	3,995	2,030	3,249	2,433

Source: OxLAD.

TABLE A.2: PPP ADJUSTMENT OF GDP

	1970 GDP		*1970 Conversion rates*	
	US$	PPP$	OER	PPP
	(1)	(2)	(3)	(4)
Argentina	23,747	84,624	3.79	2.95
Brazil	42,576	177,546	4.59	4.14
Chile	8,727	86,541	11.28	10.87
Colombia	7,200	119,797	18.44	10.68
Mexico	35,570	399,018	12.49	8.88
Venezuela	11,755	49,331	4.45	3.96
US	1,039,700	1,039,700	1.00	1.00

Notes: col. 1, GDP in US dollars at current prices for 1970; col. 2, GDP in 1970 PPP dollars for 1970; col. 3, Official nominal exchange rate for 1970, local currency units per US dollar; col. 4, PPP-adjusted exchange rate for 1970. *Sources*: col. 1, col. 2, and col. 3, OxLAD; col. 4, ECLAC (1978), p. 8.

TABLE A.3: COEFFICIENTS AND DIAGNOSTICS FROM THE UNCONSTRAINED COBB-DOUGLAS PRODUCTION FUNCTION $\log Y_t = c + a \log K_t + b \log L_t + e_t$

1900–2000	*c*	*a*	*ß*	*adj* R^2	*DW*	*F-stat*
Argentina	–0.697	0.464	0.633	0.993	0.377	6,645
	(–7.83)	(14.10)	(15.71)			
Brazil	–1.778	0.233	0.980	0.994	0.140	8,666
	(–17.45)	(5.86)	(19.39)			
Chile	–2.119	0.498	0.725	0.991	0.691	5,294
	(–20.93)	(5.05)	(9.09)			
Colombia	–2.106	0.962	0.210	0.988	0.039	4,134
	(–14.64)	(18.82)	(3.11)			
Mexico	–0.050	0.264	0.819	0.994	0.172	8,084
	(–0.65)	(7.69)	(19.99)			
Venezuela–1	–0.54	1.14	–0.23	0.991	0.145	5,723
	(–6.57)	(19.79)	(–3.09)			
Venezuela–2	–0.665	0.972	0.000	0.990	0.125	5,154
	(–7.66)	(16.05)	(0.00)			

Notes: All the fits are very good, and the capital and labour coefficients are significant at the 1 percent level (t-statistics in parentheses) and of the expected sign with the exception of labour for Venezuela ('Venezuela–1'). However, constraining the coefficients to non-negative values ('Venezuela–2') still gives an excellent fit.

TABLE A.4: DECENNIAL AVERAGE TFP GROWTH RATES (PERCENT)

	1900–9	*1910–9*	*1920–9*	*1930–9*	*1940–9*	*1950–9*	*1960–9*	*1970–9*	*1980–9*	*1990–9*	*2000*
LA6	0.5	0.0	0.4	–0.1	–0.1	0.0	0.4	0.3	–1.0	–0.3	0.6
Argentina	0.5	–0.6	0.7	–0.3	–0.1	–0.1	0.5	0.0	–1.0	0.8	–1.0
Brazil	0.7	0.2	0.0	0.0	–0.2	–0.1	0.2	0.8	–1.0	–0.7	0.5
Chile	–0.4	–1.0	2.1	–1.0	–0.2	0.3	0.4	–0.2	–0.1	0.1	0.7
Colombia	–0.1	0.1	0.2	0.9	0.2	–0.3	–0.1	0.3	–1.0	–1.0	0.5
Mexico	0.7	0.0	0.3	–0.3	–0.3	0.3	0.7	–0.1	–1.1	–0.1	1.2
Venezuela	0.3	0.5	1.6	–0.9	0.1	–0.5	0.7	–1.0	–0.7	0.5	1.4

Notes: Growth rates are arithmetic rather than geometric averages because of the problems raised by taking the root of a negative number. *Sources*: TFP rates calculated by inserting GDP figures from OxLAD and capital and labour coefficients in Table A.3 into the equation and taking first-differences to solve for a_t.

TABLE A.5: EAP AND GDP SHARES IN AGRICULTURE AND MANUFACTURING

	Agriculture				*Manufacturing*			
	1900	*1936*	*1977*	*2000*	*1900*	*1936*	*1977*	*2000*
EAP share (%)								
LA6	65.1	61.3	35.0	21.6	8.7	11.7	17.2	13.4
Argentina	38.4	35.7	13.8	10.7	19.8	21.9	21.2	13.0
Brazil	76.0	65.9	42.2	23.8	3.3	10.4	17.3	12.0
Chile	36.8	36.3	21.7	14.5	16.2	16.7	15.9	15.6
Colombia	71.7	71.7	34.4	19.6	10.2	10.2	14.3	14.3
Mexico	61.9	67.2	39.1	26.9	10.9	9.3	17.1	15.2
Venezuela	61.5	55.1	15.8	11.9	10.1	9.8	15.1	13.4
GDP share (%)								
LA6	27.6	24.9	10.7	9.5	10.5	14.5	26.1	21.9
Argentina	28.9	24.0	11.6	11.4	15.5	22.0	30.5	21.1
Brazil	23.0	23.3	8.2	8.7	12.1	13.8	29.2	21.8
Chile	16.6	15.5	8.9	6.3	15.2	18.9	23.4	19.0
Colombia	53.4	47.9	25.9	21.2	6.5	7.2	18.6	14.6
Mexico	27.9	20.7	9.8	6.6	5.7	15.3	24.0	27.3
Venezuela	23.4	25.1	6.7	7.4	10.7	10.7	15.4	16.9

Source: OxLAD.

TABLE A.6: FEMALE PARTICIPATION RATE

Participation rate in EAP	*Argentina*	*Brazil*	*Chile*	*Colombia*	*Mexico*	*Venezuela*
1950	16.9	12.7	18.0	14.3	8.4	12.1
1960	16.8	13.9	15.5	14.3	9.1	11.6
1970	19.5	16.8	13.9	14.6	11.3	12.
1980	20.7	22.2	17.8	17.1	17.6	18.5
1990	21.0	30.6	22.6	28.4	21.9	23.5
1995	23.6	31.7	24.9	30.9	24.6	26.0
2000	26.4	32.6	27.2	33.4	27.1	28.6

Source: International Labour Office (2002).

TABLE A.7: SECTORAL PRODUCTIVITY GROWTH RATES

	1900–9	*1910–19*	*1920–29*	*1930–39*	*1940–49*	*1950–59*	*1960–69*	*1970–79*	*1980–89*	*1990–99*	*2000*
Agriculture											
LA6	1.7	0.8	1.6	2.0	1.3	3.0	2.4	2.8	2.7	0.5	0.3
Argentina	2.5	1.5	0.6	1.9	0.9	3.3	2.9	2.6	0.4	0.9	–1.3
Brazil	2.4	1.4	1.5	1.6	0.1	2.7	1.6	4.4	5.2	1.0	1.3
Chile	1.9	1.1	3.4	–0.3	0.3	2.3	2.8	0.6	2.5	3.0	7.2
Colombia	–0.7	–1.1	0.9	3.5	7.0	2.7	2.9	3.3	2.8	0.3	7.4
Mexico	1.4	0.2	–0.9	3.6	1.9	3.2	2.9	0.0	–0.2	–0.1	–5.5
Venezuela	0.2	0.4	17.7	–1.2	–0.1	5.2	5.7	5.0	1.1	–1.9	2.7
Industry											
LA6	1.0	1.4	1.8	3.8	2.5	3.6	3.6	3.2	–0.1	0.7	–0.5
Argentina	2.8	–1.3	5.5	0.8	1.6	1.0	6.7	1.1	–2.3	7.4	–5.4
Brazil	–1.4	–1.7	–1.4	1.2	1.9	5.2	2.9	4.6	1.8	–1.0	–3.1
Chile	2.2	1.3	4.6	0.2	2.2	5.8	4.9	–0.2	–0.6	2.0	3.3
Colombia	–0.7	–1.1	0.3	17.5	9.4	4.4	0.4	4.4	–1.8	–1.7	8.3
Mexico	3.9	9.4	2.4	6.4	1.0	0.5	4.9	2.4	–1.1	1.9	2.0
Venezuela	0.2	0.4	17.5	0.6	3.3	6.4	1.7	–0.4	–2.1	0.0	–2.2

Source: OxLAD.

TABLE A.8: INVESTMENT SHARE OF GDP, 1900–2000

	1900–9	*1910–9*	*1920–9*	*1930–9*	*1940–9*	*1950–9*	*1960–9*	*1970–9*	*1980–9*	*1990–9*	*2000*
LA6	16.0	15.9	16.3	10.9	12.8	18.3	17.7	21.6	20.5	19.3	18.6
Argentina	24.2	18.1	19.3	14.9	13.8	16.5	20.9	22.7	19.9	17.8	16.2
Brazil	16.8	18.0	17.4	8.9	10.0	18.0	16.3	23.0	21.5	19.6	19.4
Chile	23.6	22.1	18.8	16.7	18.1	20.3	21.4	15.8	17.1	23.8	21.0
Colombia	15.8	15.3	17.8	13.9	15.8	17.8	17.6	16.1	17.6	18.5	12.7
Mexico	10.1	9.8	9.3	7.5	12.4	16.8	17.9	20.3	20.7	19.4	21.2
Venezuela	16.2	15.7	24.4	19.9	26.2	32.8	19.4	28.6	20.9	17.7	14.2

Source: OxLAD.

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