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ECONOMIC GROWTH AND PERFORMANCE IN LATIN AMERICA

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LC/L.1350
March 2000

This document was prepared by André A. Hofman, staff member of the Economic Development Division of the United Nations Economic Commission for Latin America and the Caribbean (ECLAC), for the project "Growth, Employment and Equity: Latin America in the 1990s" (HOL/97/6034), financed by the Government of the Netherlands. The author wants to thank Daniel Heymann, Barbara Stallings, Jaime Ros and participants at several seminars at ECLAC for comments on earlier drafts. The views expressed in this document are those of the author and do not necessarily reflect the views of the Organization.

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I. INTRODUCTION

This paper addresses some important questions with respect to economic growth in Latin America, comparing the so-called post-crisis period and the 1990s with a base period in a selected group of nine countries (Argentina, Bolivia, Brazil, Chile, Colombia, Costa Rica, Jamaica, Mexico and Peru)[1]. Latin America experienced steady economic growth in the three decades after World War II, with total gross domestic product (GDP) growing at around 5%. This period serves as the base period against which to analyse the developments in the 1980s and 1990s. The profound crisis of the 1980s revealed some of the structural weaknesses of Latin American economic development. In response, most countries of the region felt compelled to undertake structural reforms with the aim of creating more stable economies which would form a more integral part of the international context and which would be capable of significant and sustainable growth.

This paper forms part of an ambitious project to study the impact of the reform processes listed above in nine countries. The basic objective of the project is to study the relation between the structural reforms applied in the region in the last decade, which have led to a change in the Latin American development model, and their impact on economic growth, equity and employment. The relevant theme of the project is to analyse the impact of the economic reforms, through the economic structure, on economic growth.

Special emphasis is given in this paper to economic growth and to differences in intercountry and intertemporal GDP growth rates of in the sample of countries. The performance of the selected economies on the aggregate level is analysed in terms of economic growth, factor accumulation and different types of productivity.

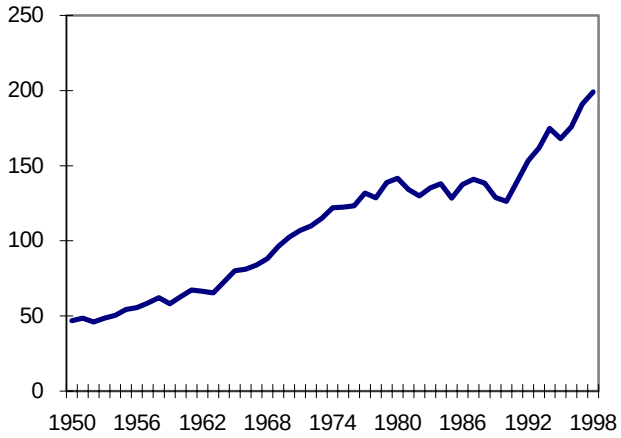
II. PERIODIZATION

The periodization used in this paper is fundamental for correctly appraising the growth performance of Latin America in the last decades and especially after the crisis of the 1980s. The variable used in this paper to define the periods is total GDP growth. The periods are selected on the basis of fundamental turning points in growth momentum. Because the objective of the project "Growth, Employment and Equity: Latin America in the 1990s" is to analyse the relation between the variables mentioned in the project title and the reforms implemented in Latin America in the late 1980s and 1990s, the benchmarks identified in this study might differ from those of the other modules in which reforms variables define the periods.

This paper studies the relation between accumulation, productivity and economic growth. It is therefore important to take into account that part of labour supply and capital stock which may be idle in certain periods, especially directly after an economic crisis. In these periods, economic growth can be resumed by moving towards the production frontier through the better utilisation of installed capacity and the labour force with a minor accumulation effort. To facilitate comparisons, periods with production at the production frontier, or with similar supply capacity utilisation, have to be identified. Therefore, if necessary, a recovery period is identified, implying a movement toward the production frontier. We used a very simple technique for determining recovery period, which is defined as the period from the trough until the previous peak level of total GDP is reached. The post-crisis performance is evaluated in comparison with a base period, which reflects the former development model in a period of stable growth. For almost all countries of our sample this is reflected in the period 1950-1980 (except for Bolivia, where the base period ended in 1978, and especially Chile, where the base period is 1950-1970).

The following nine figures present total GDP for each country for the period 1950-1998.

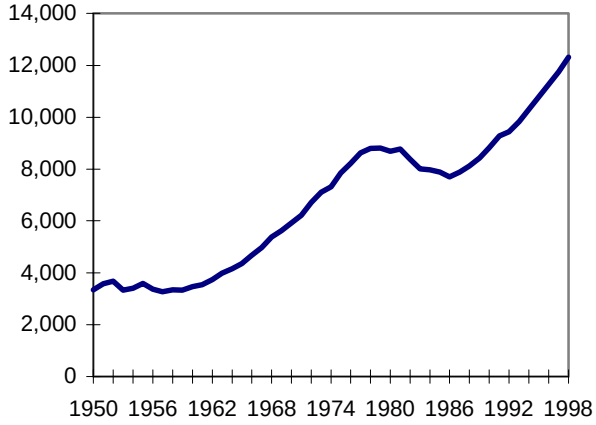
Figure 1
ARGENTINA: TOTAL GDP, 1950-1998
(Billions of 1980 international dollars)



Source: Author's calculations, on the basis of project data.

In the case of Argentina the post-war growth path came to a halt in 1980, and the country only started growing again from 1990 onwards, after a period of instability and strong economic fluctuations (see figure 1). The previous peak level was reached in 1992. The chosen periodization consists of a 1950-1980 base period of growth, a 1980-1990 crisis period, a 1990-1992 recovery period and a 1992-1998 new growth period.

Figure 2
BOLIVIA: TOTAL GDP, 1950-1998
(Billions of 1980 international dollars)

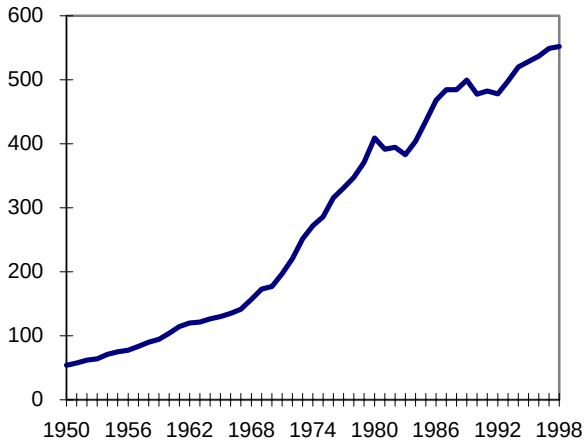


Source: Author's calculations, on the basis of project data.

The Bolivian growth experience in the post-war period is rather singular (see figure 2). Growth started faltering at the end of the 1970s, and Bolivia embarked on a substantive reform programme in the mid-1980s. The base period was therefore defined as 1950-1978, and from

1978-1986 the country was in crisis. The recovery period was 1986-1990; the country resumed a period of stable growth in 1990-1998.

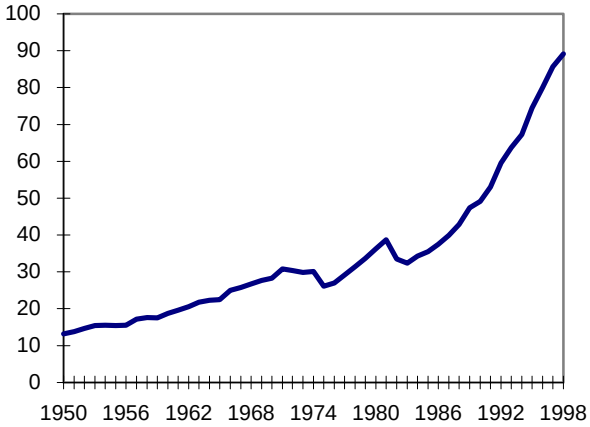
Figure 3
BRAZIL: TOTAL GDP, 1950-1998
(Billions of 1980 international dollars)



Source: Author's calculations, on the basis of project data.

The well-documented growth path of Brazil was rapid until the 1980s (see figure 3). Since then growth has been interrupted. In this case, the crisis period was from 1980-1992 and the growth period was 1992-1998. A recovery period has not been identified, as Brazil did not experience an extreme fall in total GDP.

Figure 4
CHILE: TOTAL GDP, 1950-1998
(Billions of 1980 international dollars)



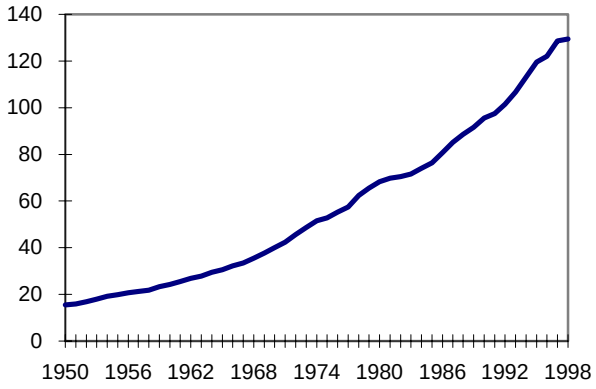
Source: Author's calculations, on the basis of project data.

Chile has the longest reform period of the sample. From 1975 onwards, after the military coup of 1973, a vast reform program was implemented. As can be seen from figure 4 Chile

experienced a very deep crisis at the beginning of the 1980s. For the periodization, the base period is 1950-1970. The crisis period from 1970 to 1984 is long, and from 1976 to 1981 the country experiences rather strong economic growth but overall growth, in 1970-1984 is low (1.4%). From 1984 onwards the Chilean economy grew rapidly and reaching its former peak level in 1987. Therefore 1984-1998 is the post-crisis period, with 1984-1987 as the recovery period.

Annual economic growth of the Chilean economy in the post-war period (1950-1998) was 3.9%. It is interesting to note that exactly the same annual growth was found in the 1950-1970 and the 1970-1998 subperiods.

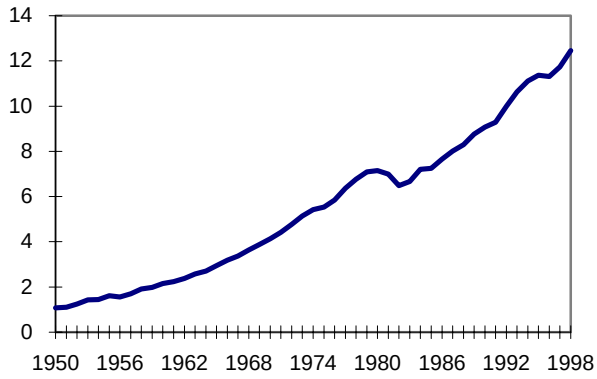
Figure 5
COLOMBIA: TOTAL GDP, 1950-1998
(Billions of 1980 international dollars)



Source: Author's calculations, on the basis of project data.

Colombia has historically been the Latin America country with the smoothest growth path, without violent crisis, as is clear from figure 5. The benchmarks elected are 1980 and 1986, resulting in a base period of 1950-1980, a "crisis period" from 1980-1986 and a growth period of 1986-1998. Graphical inspection shows no fall in total GDP for the whole 1950-1998 period and therefore no recovery period was defined. As a matter of fact, the last fall in Colombia's total GDP occurred in 1931.

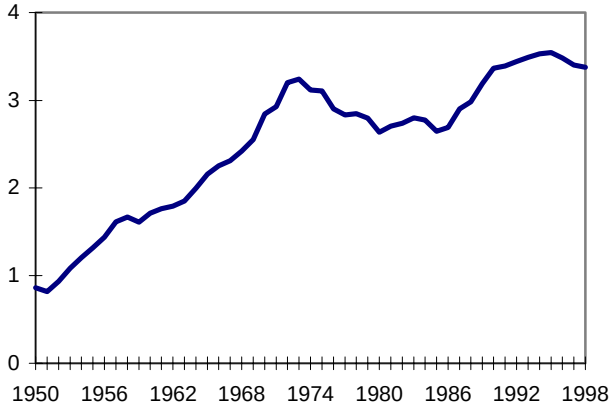
Figure 6
COSTA RICA: TOTAL GDP, 1950-1998
(Billions of 1980 international dollars)



Source: Author's calculations, on the basis of project data.

In the case of Costa Rica, 1980 marks the start of the crisis and in 1984 the previous peak level had been reached (see figure 6). Therefore, the periods 1950-1980, 1980-1984 and 1984-1998 have been chosen, with no recovery period.

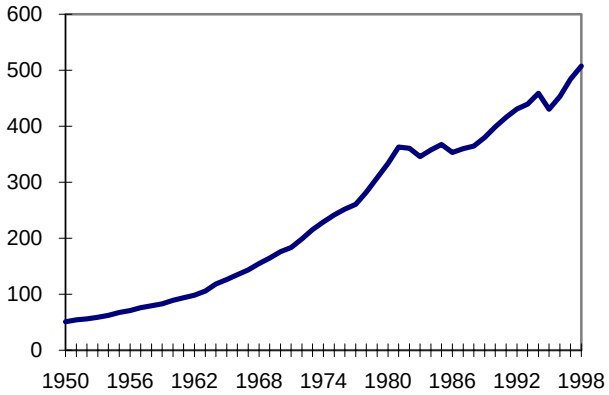
Figure 7
JAMAICA: TOTAL GDP, 1950-1998
(Billions of 1980 international dollars)



Source: Author's calculations, on the basis of project data.

The selection of benchmarks is somewhat complicated in the case of Jamaica, as becomes clear from figure 7. The Jamaican economy grew fast up to the mid-1970s and 1950-1974 was selected as the base period. Jamaica started growing again in 1986. The crisis period chosen is 1974-1986 and a growth period of 1986-1998. No recovery period was identified.

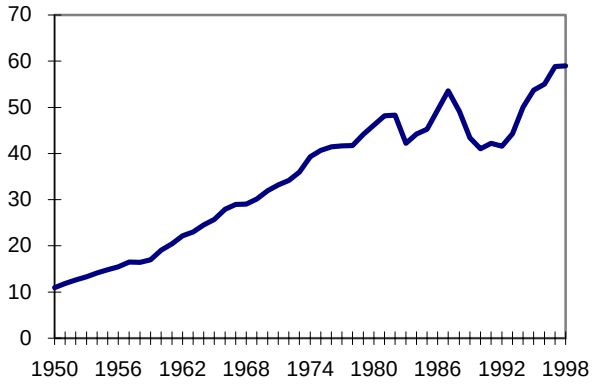
Figure 8
MEXICO: TOTAL GDP, 1950-1998
(Billions of 1980 international dollars)



Source: Author's calculations, on the basis of project data.

As can be observed from figure 8, the period 1950-1980 was one of stable growth in Mexico. At the beginning of the 1980s, however, Mexico was not able to meet its international financial obligations, and this marked the beginning of one of the worst international financial crisis since the Great Depression of the 1930s. A new growth period started in 1986, and in 1989 the previous peak level was reached. The proposed benchmark periods are therefore 1950-1980, 1980-1986 and 1986-1998, with a recovery period of 1986-1989. The growth period is 1989-1998, although 1995 shows a marked recession.

Figure 9
PERU: TOTAL GDP, 1950-1998
(Billion 1980 international dollars)



Source: Author's calculations, on the basis of project data.

In the case of Peru it is not as easy is in other countries to identify the different periods (see figure 9). Stable growth characterized the 1950-1980 period, so this constitutes the base period. In the 1980s growth was very unstable, including years of very fast growth and big recessions during the Garcia administration. Only from 1990 onwards was a new growth period

established, and only in 1994 was the previous peak level reached. The periodization is therefore as follows: 1950-1980 (base period), 1980-1990 (crisis period) and 1990-1998 (growth period), with a recovery period of 1990-1994.

Table 1 summarizes the above- periodization for the nine countries. It is clear that 1950-1980 is an acceptable base period in most countries, except Bolivia, Chile and Jamaica. The crisis period ends for most countries in the middle of the 1980s and for the rest in the beginning of the 1990s.

Table 1
PERIODISATION OF BASE PERIOD, CRISIS PERIOD AND POST-CRISIS PERIOD

Country	Base period	Crisis period	Post-crisis period	
			Recovery	Growth
Argentina	1950-80	1980-90	1990-92	1992-98
Bolivia	1950-78	1978-86	1986-90	1990-98
Brazil	1950-80	1980-92	…	1992-98
Chile	1950-70	1970-84	1984-87	1987-98
Colombia	1950-80	1980-86	…	1986-98
Costa Rica	1950-80	1980-84	…	1984-98
Jamaica	1950-74	1974-86	…	1986-98
Mexico	1950-80	1980-86	1986-89	1989-98
Peru	1950-80	1980-90	1990-94	1994-98

Source: Authors calculations.

The above periodization proposed is based on the growth rates of total GDP and does not reflect other influences, such as demographic changes. Additionally these benchmark may differ substantially from a periodization on the basis of the implementation level of the reforms analysed in "Growth, Equity, and Employment" (namely, trade, financial, capital account, labour and privatisation reforms). In the modules on investment, employment and technical progress, therefore, the periodization can differ; some of these reforms might have a more important weight in explaining performance than others.

The analysis in this chapter is on the aggregate level. As the analysis in the modules is of a more microeconomic (or mesoeconomic) character, comparing the aggregate and more microeconomic results becomes very important; a careful effort has to be made to explain differences in results by differences in coverage, methodology or other factors. The results on the microeconomic level will give valuable insights on winners and losers in terms of growth and productivity, but these results will have to be evaluated in the light of overall performance. An important aspect of the project, therefore, is the interpretation of the micro and mesoeconomic results of the respective modules on employment, investment and technical progress on the aggregate level.

III. ECONOMIC GROWTH

The nine countries in the sample were selected on the basis of various criteria. Chile, Mexico and Bolivia form a core group with the longest experience implementating structural reforms. It was also important to include other large and medium-size countries with shorter experience with the reform process, but where some important conclusions can still be drawn. Costa Rica and Jamaica, from Central America and the Caribbean, were selected to study the effects of size and geographical location.

Table 2
TOTAL GDP GROWTH IN SELECTED PERIODS
(Average annual compound growth rates)

Country	Base period	Crisis period	Post-crisis period		1990s
			Recovery	Growth	
Argentina	3.8	-1.1	10.1	4.5	5.8
Bolivia	3.5	-1.7	3.5	4.3	4.3
Brazil	7.0	1.3	…	2.4	1.8
Chile	3.9	1.4	5.2	7.6	7.7
Colombia	5.1	2.8	…	3.8	3.6
Costa Rica	6.5	0.2	…	4.0	4.0
Jamaica	5.5	-1.2	…	2.1	0.2
Mexico	6.5	1.0	2.4	3.3	3.1
Peru	4.9	-1.2	5.1	4.2	4.6
Simple Average	5.2	0.2	5.3	4.0	3.9
Weighted Average	6.0	0.8	4.9	3.4	3.2

Source: ECLAC, on the basis of project data.

Table 2 presents the results with respect to GDP growth for the sample group of countries in the periodization analysed in the previous section The results show that economic growth in the post-crisis period is somewhat lower than the growth rates experienced in the base period (5.2%). During the so-called lost decade" of the 1980s, growth collapsed, and growth rates in the post-crisis period are around 4% on average.

Table 3 presents growth of per capita GDP growth, which is an additional important performance indicator. Important differences can be observed between tables 2 and 3. Per capita growth is very similar in the base period and the post-crisis period, with an average around 2.5%, as compared to bigger differences between periods in the total GDP estimates of table 2. The fall in the population growth rate in the post-war period explains this difference between total and per capita GDP growth in terms of comparing base period and post-crisis period.

Table 3
GDP PER CAPITA GROWTH IN SELECTED PERIODS
(Average annual compound growth rates)

Country	Base period	Crisis period	Post-crisis period		1990s
			Recovery	Growth	
Argentina	2.1	-2.6	8.7	3.2	4.6
Bolivia	1.2	-2.9	1.3	2.1	1.8
Brazil	4.1	-0.7		0.8	0.1
Chile	1.6	-0.2	3.5	5.4	6.1
Colombia	2.3	1.3		2.0	1.9
Costa Rica	3.1	-2.6		1.5	1.4
Jamaica	2.4	-1.5		1.2	-0.8
Mexico	3.5	-2.0	0.4	1.7	1.2
Peru	2.1	-2.7	3.3	2.4	2.8
Simple Average	2.5	-1.5	3.5	2.2	2.1
Weighted Average	3.2	-1.3	3.1	1.7	1.5

Source: ECLAC, on the basis of project data.

It is important to bear in mind that tables 2 and 3 present the simple average of growth in the nine countries. However, the results shown above are rather sensitive to weighting. Table 4 shows the weighted averages based on the proportion of each country's GDP in the total GDP of the sample. Base period growth in that case amounts to 6% and in the post-crisis growth period, growth rates between 3% and 4% are found. In the case of per capita growth, the results are 3.2% on average in the base period and somewhat below 2% in the post-crisis period.

The basic unit of analysis used in the project is countries, and it therefore seems logical to give each country's reform process a similar weight as reflected in a simple average. Weighted averages are too heavily influenced by the data on Brazil and Mexico, as can be seen by comparing the simple and weighted averages in tables 2 and 3. Therefore, the analysis in this paper is largely based on the unweighted simple averages of the countries.

What the averages do not show adequately, however, is the fact that the relative performance of the countries between the periods has changed quite drastically. The three highest performers in the post-crisis period (Peru, Chile and Argentina) were very low performers in the pre-crisis period. Their average growth rate in the base period was 4.1%. This rate increased to 6.3% in the post-crisis growth period.

On the other hand, the high performers in the base-period (Brazil, Mexico and Costa Rica) are among the lowest performers in the post-crisis period, and they are the countries with the highest deceleration of growth between the two periods. Average growth rates in the base period for these three countries was 6.7%, which falls to 3.8% in the post-crisis period.

Only Bolivia and Colombia show equivalent performances in both periods, with medium to low growth rates. Colombia was also the least affected by the 1980s crisis (see figure 5).

Jamaica had lowest performance of the sample group in both the base-period (together with Argentina, Bolivia and Chile) and the post-crisis period.

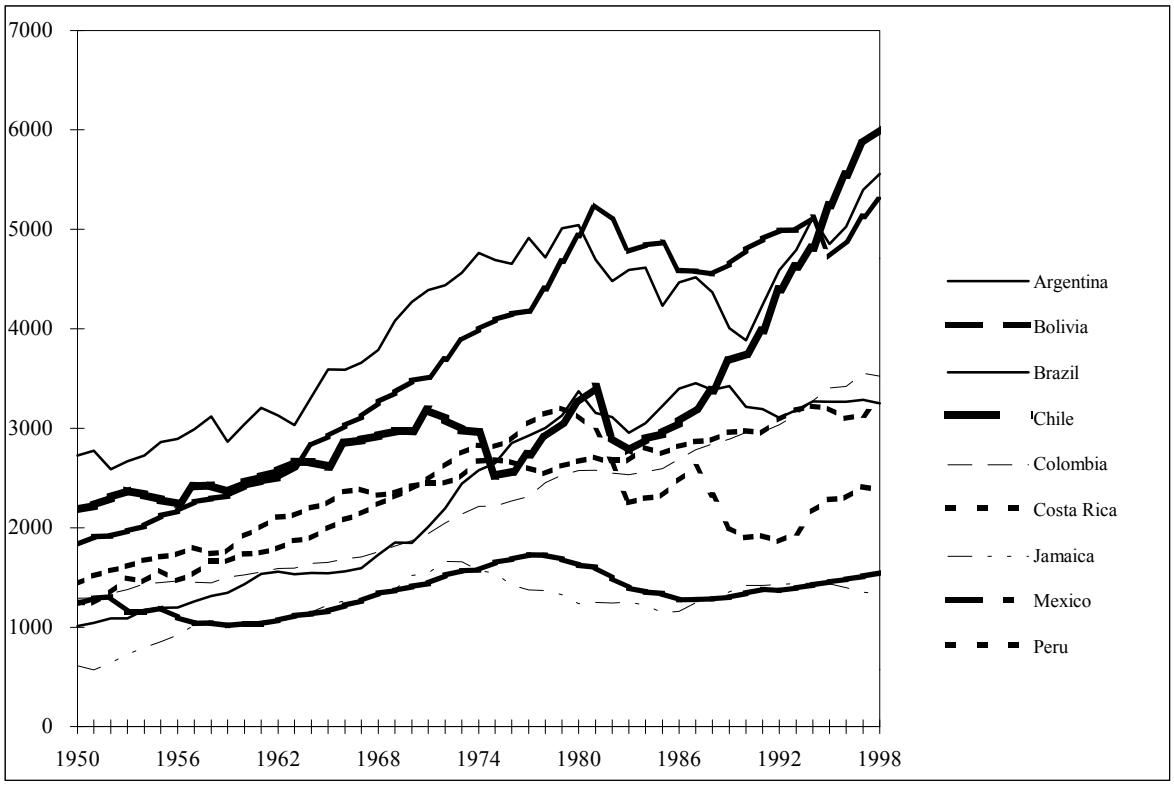
The post-crisis period is also analysed in terms of a recovery period and the instalment of a stable growth path. The methodology applied in this case is to define the post-crisis period as starting when growth was resumed. The recovery period is defined from this starting point until the pre-crisis peak level was reached; the period after that is the so-called stable growth path.

Academic and development policy communities tend to take the positive relation between reforms and economic growth for granted. For example, Fernández-Arias and Montiel (1997 pg.4) emphasise that "There is a strong professional consensus, based on a substantial amount of cross-country experience both internationally and within Latin America itself, that macroeconomic stabilization and market-oriented structural reform are conducive to the acceleration of long-run growth". However, the empirical results of the post-reform period are not so straightforward as this quotation indicates. Economic growth here is analysed through time, by change in growth path, by change in composition of countries in high and low-growth groups and by other factors.

To analyse whether the heterogeneity among countries has increased or decreased, a check has been made for trends in per capita GDP. The concept used to test the tendencies with respect to structural heterogeneity in the sample countries is convergence. The literature distinguishes different types of convergence, including absolute versus conditional and ß-convergence versus s-convergence. Absolute convergence refers to the hypothesis that poor countries tend to grow faster per capita than rich ones, without conditioning for any other characteristic of the economies. Conditional convergence assumes that all countries have the same parameters, and therefore the same steady state position is dropped. Conditional convergence refers to the concept that an economy grows faster the further it is from its own steady state value. ß-convergence refers to the concept that poor countries tend to catch-up with rich ones in terms of per capita income or GDP. The concept of s-convergence concerns cross-sectional dispersion: convergence occurs if the dispersion, for example measured by the standard deviation of the logarithm of per capita income across a group of countries, declines over time.

For a graphical inspection of convergence trends, figure 10 presents per capita GDP for the nine countries for the 1950-98 period.

Figure 10
PER CAPITA GDP, 1950-1998
(1980 international dollars)



Figures 11 and 12 depict the formal tests for conditional ß-convergence, which relates the logarithm of per capita GDP at the beginning of the period with the per capita growth rate of the period. Figure 11 indicates a certain level of conditional ß-convergence for our group of countries in the 1950-1980 base period.

Figure 11
CONVERGENCE OF PER CAPITA GDP, 1950-1980

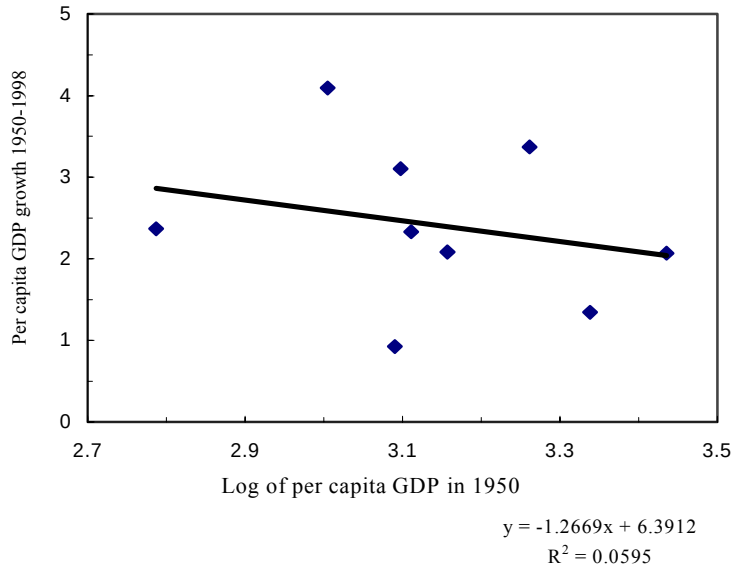
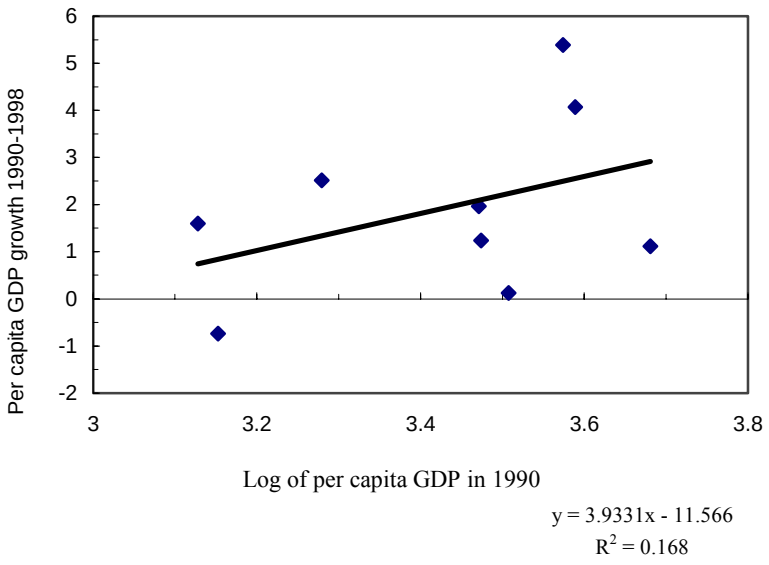


Figure 12, however, shows that no conditional ß-convergence took place in the 1990s. This point to an increased heterogeneity between the countries of our sample in the post-crisis period and confirms at the country level what was found in the modules in terms of increasing heterogeneity at a more disaggregate level.

Figure 12
CONVERGENCE OF PER CAPITA GDP, 1990-1998



Barro and Sala-i-Martin (1995) state that the neo-classical model predicts that each economy converges to its own steady state and that the speed of this convergence relates inversely to the distance from the steady state. In other words, the model predicts conditional convergence in the sense that a lower starting value of real per capita income tends to generate a higher per capita growth rate, once we control for the determinants of the steady state.

The endogenous growth theory introduces several new elements. One of the most important is the assumption of constant returns to production factors. Furthermore, new models have been developed which incorporate the creation and diffusion of research and development (R$D) and the assumption of imperfect competition. In these frameworks the long-run growth rate depends on government action, which was basically exogenous in the neo-classical framework.

Accumulation

One important aspect in the evaluation of the impact of the reforms is their effect on the accumulation of capital and labour. This aspect will, of course, be analysed in great detail in the modules on investment, employment and technological progress. This paper provides a first orientation in terms of accumulative performance of the different countries over the different periods. Whenever possible, this orientation includes qualitative elements, such as level of education in the case of labour and age structure of the capital stock in the case of capital formation, to evaluate the performance.

Among the most striking results in this paper are those presented in table 4 with respect to trends in factor accumulation. An important increase in labour input growth clearly took place in the post-crisis growth period, as well as in the 1990s. In contrast, capital accumulation fell sharply between the base period and the later periods. With respect to labour accumulation, this also means a stronger increase of persons working, as hours worked per person have fallen in most countries. The increase is particularly strong in Bolivia, Chile and Costa Rica. Labour accumulation fell sharply only in Brazil. Brazil also displays the strongest fall in capital accumulation, together with Mexico. However, capital accumulation fell in almost all countries, with the exception of Bolivia and Chile.

Researchers have devoted considerable effort to capturing quality changes in labour input. The most important of these, considered to have a direct effect on productivity, is the level of education and its rate of change. The developed countries and successful late industrialisers clearly recognize the central role that education and the generation of knowledge play in the development process, and this attitude has been spreading gradually to the countries of Latin America. In most countries of the region, the systems of education, training and scientific and technological development have undergone noteworthy expansion in the last decades. They still display shortcomings, however, in terms of the quality of their results, their degree of adaptation to the requirements of the economic and social environment and the extent to which they are accessible to the different strata of society (ECLAC/UNESCO, 1992).

Table 4
CAPITAL AND LABOUR ACCUMULATION IN SELECTED PERIODS
(Average annual compound growth rates)

Country	Labour input growth (hours worked)			Capital accumulation		
	Base period	Post-crisis growth period	1990s	Base period	Post-crisis growth period	1990s
Argentina	1.2	1.5	1.5	4.1	2.9	2.5
Bolivia	1.0	3.5	3.5	2.8	3.3	3.3
Brazil	2.9	1.4	1.4	9.8	2.7	2.6
Chile	0.4	2.9	2.8	4.2	6.2	6.8
Colombia	2.3	2.0	2.0	4.1	3.8	3.8
Costa Rica	2.9	3.4	3.1	7.2	4.4	4.6
Mexico	2.6	3.0	3.1	7.7	2.4	2.4
Peru	2.0	2.9	3.0	5.0	3.7	2.9
Simple Average	1.9	2.6	2.5	5.6	3.7	3.6

Source: ECLAC, on the basis of project data.

Table 5 presents evidence on changes in the educational levels for the sample countries. The rise in the average educational level of the population in the post-war period has had a crucial effect on the quality of labour. An individual's level of education affects the type of work he or she can do and the efficiency with which work is performed.

The number of years of formal education enjoyed by the population aged 15 to 64 years is probably not the most adequate measure of quality change. First, some authors consider the labour force to be a more relevant unit of analysis, and second, important elements such as on-the-job training are not taken into consideration. Unfortunately, in Latin America, the only data available for the whole period and for all countries concerns years of formal education. Higher levels of education for the population as a whole do have positive effects, however, especially in terms of adaptability to changing markets and new technologies; these factors assume greater importance in the global integration process marked by rapid changes in markets and technologies and, in the case of Latin America, by export-oriented development strategies.

Comparing the educational level of the total population and of the labour force reveals that differences are small at the primary level but can be significant at the tertiary level. Information on the educational level of the labour force, which is obtained from population censuses, is only available for a few benchmark years in a limited number of countries. Hence, average years of formal education of the population is the best proxy available for human capital improvement.

As regards on-the-job training, Psacharopoulos (1993) indicates that there exist strong education-training complementarities. Psacharopoulos and Vélez (1992) find a strong positive interaction between training and years of formal education in determining earnings in Colombia. They conclude that training really has an effect on earnings only after a worker has eight years of formal education. Mingat and Tan (1988) confirm these findings. They conclude that training is particularly productive when a country's education system is highly developed. The rate of return

on training is, according to their most conservative estimate, on the order of 20%, assuming that 50% of the population is literate.

Table 5
GROWTH AND LEVEL OF EDUCATION IN SELECTED PERIODS, 1950-1998
(Average annual compound growth rates and equivalent years of education)

Country	Education growth			Equivalent years of education at end of each period		
	Base period	Post-crisis growth period	1990s	Base period	post-crisis growth period	1990s
Argentina	1.8	1.7	1.7	8.6	11.8	11.8
Bolivia	3.0	3.0	3.0	4.6	8.3	8.3
Brazil	2.9	2.6	2.6	4.7	7.4	7.4
Chile	1.8	2.1	2.0	7.0	12.3	12.3
Colombia	2.7	3.8	3.8	5.9	11.4	11.4
Costa Rica	1.9	2.1	2.0	8.5	12.3	12.3
Mexico	3.7	2.2	2.2	6.5	9.5	9.5
Peru	3.0	1.3	1.3	6.3	8.0	8.0
Simple Average	2.6	2.3	2.3	6.5	10.1	10.1

Source: ECLAC, on the basis of project data.
Note: Equivalent years of education determined using the following weights: 1 for primary, 1.4 for secondary and 2 for higher education.

Unfortunately, as education expanded in Latin America, its overall quality declined, and the education system became more inefficient. Several factors can be identified. One was the explosion of social demand for education, which led to the incorporation of more and more children, without redefining the educational content or increasing resources to meet expanded enrolments. Moreover, the traditional preference for physical investments over qualitative ones and the lack of interest in education also contributed to a poor implementation of the growth of the education system, with the corresponding deterioration in results. In Latin America, it is of fundamental importance to design and carry out a strategy for promoting the transformation of education and training and for increasing the scientific and technological potential of the region, which makes sustained growth possible on the basis of the incorporation and diffusion of technological progress (ECLAC/UNESCO, 1992). A very important consideration is whether the quantity indicator (i.e., years of education) also reflects the quality changes that have occurred in the sample countries. The crisis of the 1980s affected the quality of education in Latin American countries. Although assessing quality changes is very difficult, some aspects of deteriorating education in Latin America are indicated below, together with policies for improving the quality of education.

One striking difference between Latin America and other regions is its much higher level of grade repetition, especially in the first grade, for which the repetition rate was 50% in 1980 and 42% in 1988[2]. Some grade repetition occurs in any school system because some students are not yet mature enough to be promoted or they show some learning disability. Such students benefit enough from repetition to make it efficient from an economic viewpoint. Very high repetition rates suggest a major problem, however, the greatest problem lies not in the lack of

schools but in the quality of education. High repetition rates limit access to education, delay entrance and have high resource costs. Some rather simple measures have been suggested for the schooling system, such as wider provision of textbooks and writing materials, which could reduce the enormous amount of resources now devoted to grade repetition (IDB, 1993).

Microeconomic-evidence on the effects of schooling indicates that the impact of educational attainment on wages and economic productivity is considerable. One important element, as indicated above, is the fact that schooling has both important private and social returns. In fact, IDB (1993) indicates that private returns are lower and social returns higher than in standard estimates.

Psacharopoulos gives a brief summary of the recent research on returns to investment in education: primary education continues to be the number one investment priority in developing countries; educating females is marginally more profitable than educating males; the general secondary school curriculum is a better investment than the technical/vocational track; and the returns to education obey the same rules as investment in conventional capital (i.e., they decline as investment expands) (Psacharopoulos, 1993). As mentioned above, however, in the endogenous growth theory, constant or even increasing total (private and public) return to scale was assumed in a context of imperfect competition.

One of the most important factors explaining Latin America's economic performance is accumulation through investment and capital stock formation. This analysis concentrates on the role of capital stocks in growth accounting and the role of investment in the periods under consideration. Growth accounting only becomes possible if reliable estimates of the flow of services from physical capital are available. To draw an analogy with labour, one would like to know the amount of machine hours used in production during the period of reference. However, the lack of available data normally does not permit this procedure. The generally accepted proxy for this calculation is the estimation of the capital stock based the perpetual inventory model developed by Raymond Goldsmith (1951). The capital stock was thus disaggregated into (a) machinery and equipment, (b) structures and (c) dwellings, with service lives of 15, 40 and 50 years, respectively. The perpetual inventory model provides an indication of productive capacity. It includes all capital assets, but some of these may be temporarily idle and others may have been withdrawn from production and held in reserve in case of an unexpected rise in demand.

The service lives used in this method refer to the total length of time from the initial installation of assets to the moment when they are finally scrapped. Clearly, these lives may include periods when some assets are not being used to produce anything. In this study, capital stock estimates are basically used to explain Latin America's past performance. Capital is thus understood in the ex post sense, that is, in its observable role as a factor input in the production process. This notion should be distinguished from the concept of capital as an indicator of net worth which embodies potential economic services and has the capacity to generate future income. The present net worth of a capital asset, which is related to its future earning potential, progressively declines as it gets older, even though the annual real value of its services may remain unchanged over time.

An important element in the analysis of economic performance, which was first put forward by Robert Solow (1962), is the idea of embodying technical progress in the form of quality improvements in successive vintages of capital. The basic argument is that physical investment is the prime vehicle by which technical progress is realized. The debate is about whether technical progress is due primarily to improvements in the design of new capital (i.e., embodiment) or is mainly disembodied and thus independent of the rate of capital formation. This capital embodiment effect is not a catch-all effect of technical progress (as suggested initially by Solow), because an important part of technical progress is embodied in the labour force and consists of organizational and other improvements. This quality effect is the result of three forces: embodied technical progress, changes in the average age of the stock and changes in its composition. If the average age of the capital stock goes down, the embodiment effect increases, as newer vintages will have more weight in the total capital stock. Table 6 presents the changes in composition of capital formation between the different sub-periods. On average, the most important finding is a relatively small increase in the importance of machinery and equipment in capital formation and a fall in non-residential construction.

Table 6
COMPOSITION OF FIXED CAPITAL FORMATION IN SELECTED PERIODS
(Percentage of total fixed capital formation)

	Base period			Crisis period			1990s		
Country	D	NRC	M&E	D	NRC	M&E	D	NRC	M&E
Argentina	39	34	27	45	16	39	44	16	40
Bolivia	14	37	49	15	37	48	15	37	48
Brazil	23	35	42	26	40	34	26	41	33
Chile	29	37	34	21	39	41	21	37	42
Colombia	20	40	40	19	32	49	20	28	52
Costa Rica	18	46	35	15	33	52	13	32	55
Mexico	22	45	34	29	27	44	29	26	45
Peru	23	33	44	34	45	21	34	45	21
Average	24	38	38	26	34	41	25	33	42

D: dwellings; NRC: non-residential construction; M&E: Machinery and equipment.
Source: ECLAC, on the basis of project data.

It has been argued that existing differences in technology among developed countries are increasingly related to differences in work practice and shop-floor organization; these are typical features of disembodied rather than embodied technological change (Van Ark, 1993). In the case of Latin American countries, however, the level of difference between their capital stock and that of the technological leaders is still very substantial. It therefore seems reasonable to assume that technological advance in Latin America will largely take place through the embodiment of technology in the capital stock.

The age of capital is the empirical manifestation of the vintage effects, and this analysis shows a secular trend of a falling average age of the capital stock for all countries except Brazil. Directly measuring the vintage effect is very difficult, but the empirical information on age gives us a clue as to its importance. However, age is only one factor in the embodiment effect. A

recent article by Hulten (1992) shows that the failure to adjust capital explicitly for quality changes diverts the quality effects into the conventional total-factor-productivity residual. Hulten found that approximately 20% of the residual growth of quality-adjusted output could be attributed to embodied technical change. This estimate is based on the American economy, using data obtained from the United States Bureau of Labor Statistics and Gordon (1990).

Table 7 we present the average age of the capital stock aggregates, dwellings, non-residential construction and machinery and equipment, which gives an indication of the incorporation of new technology in the production process. In the vintage approach, applied in the construction of the capital stocks, a falling age means that more recent vintages are becoming more important in the capital stock. These more recent vintages will incorporate the newest technology and therefore a falling age indicates an increase in embodied technical progress.

Table 7
AVERAGE AGE OF CAPITAL STOCK AGGREGATES, 1950-1998
(years)

	Dwellings				Non-Residential construction				Machinery & equipment			
Country	1950	1980	1990	1998	1950	1980	1990	1998	1950	1980	1990	1998
Argentina	23.3	16.0	19.1	19.1	16.2	14.2	19.0	20.7	7.3	6.9	8.1	7.1
Bolivia	20.3	18.0	19.4	18.2	17.2	15.6	16.5	16.3	7.7	6.8	9.1	6.0
Brazil	15.9	12.2	14.2	16.9	13.1	9.7	12.9	15.5	6.2	6.3	8.5	7.5
Chile	18.3	20.8	23.1	19.0	17.4	17.0	16.8	14.2	6.9	7.5	7.3	5.4
Colombia	15.4	18.3	18.4	16.8	16.3	14.6	14.6	16.2	6.3	6.6	7.4	6.6
Costa Rica	19.9	13.7	16.1	17.5	16.9	12.4	15.0	15.6	5.8	6.5	8.1	6.9
Mexico	14.1	11.6	14.0	15.6	12.0	13.5	15.4	17.2	5.8	6.5	8.1	6.9
Peru	23.3	16.0	19.1	19.1	16.2	14.2	19.0	20.7	7.3	6.9	8.1	7.1

Source: ECLAC, on the basis of project data.

The 1990s demonstrate some interesting results. Only in Chile did the average age fall for all types of capital. In fact, all other countries saw an increase in the average age of non-residential construction. This tendency toward increasing age is also found in the stock of dwellings, although the trend is not as straightforward as in the case of non-residential construction. In the case of machinery and equipment, on the other hand, all countries, without exception, show falling average ages.

Table 8 specifies fixed capital formation as a percentage of GDP, for the eight countries in the different subperiods, which gives an indication of their investment effort.[3] This investment effort measures the fraction of GDP not used for consumption purposes. It is not, however, a good measure for the expansion of the productive capacity.[4]

Table 8
AVERAGE FIXED CAPITAL FORMATION IN SELECTED PERIODS
(Percentage of GDP)

Country	Base period	Post-crisis growth period	1990s
Argentina	20.1	19.9	19.0
Bolivia	14.7	16.6	16.6
Brazil	19.3	15.6	15.4
Chile	20.9	23.2	24.7
Colombia	16.1	17.1	17.7
Costa Rica	18.3	21.3	22.3
Mexico	19.1	18.7	18.9
Peru	21.0	22.9	20.9
Simple Average	18.7	19.4	19.4
Weighted Average	19.2	18.0	18.0

Source: ECLAC, on the basis of project data.

Comparing the investment coefficients in table 8 with the growth of the capital stock in table 4 draws attention to the increase in the average investment coefficients between the base period and the post-crisis growth period, particularly the 1990s. This difference can be explained in several ways. In a period of high growth, for example that experience by Brazil and Mexico in the base period, capital stock grew fast while capital formation as a percentage of GDP grew much slower precisely because of the high GDP growth (the denominator). Also, the result is quite different between the simple and weighted averages presented in Table 8.

Productivity

This section analyses the evolution of labour and capital productivity growth, as well as the role of the residual in the growth process. One of the most important issues with respect to economic growth is the role of technical progress. The modules on investment, labour and technical progress provide detailed sectoral analysis.

This kind of growth-accounting exercise may serve different purposes, such as explaining differences in growth rates between countries, illuminating the process of convergence and divergence, assessing the role of technical progress and calculating potential output losses. Growth accounting cannot provide a full causal explanation, however. It deals with "proximate" rather than "ultimate" causality and records the facts about growth components: it does not explain the underlying elements of policy or the national or international circumstances, but it does identify which facts need further explanation.

Ultimate causes are those factors related to economic growth which are difficult to quantify in economic or statistical models. They include the role of institutions, ideologies, pressures from socio-economic interest groups, historical accidents and economic policy at the national level. They also involve consideration of the international economic order, foreign

ideologies and shocks originating from friendly or unfriendly neighbours. The ultimate sources of Latin American performance are less clearly established than its proximate causes, and they constitute an extremely interesting area for further research.

The proximate causes are not independent of the ultimate causes of growth. To a significant degree, proximate causes are dimensions through which ultimate causes can be seen to operate. The important point here, however, is that the different sources of growth interact and are interdependent. On the proximate level, the interaction between capital accumulation and technological progress is an example of this interdependence. On the ultimate level, the institutional framework of a society interacts with the implementation of economic policy. An example of interdependence between the ultimate and proximate levels is the relation between technological progress and the institutional context.

It is important to evaluate the role of productivity and technical progress in comparison with previous periods. One of the major reasons for the implementation of the structural reforms was Latin America's rather disappointing productivity performance in the past, especially in terms of total factor productivity. This chapter makes a first evaluation of the results with respect to the evolution of capital, labour and total factor productivity in the post-reform period. The different modules then contrast these macroeconomic results with the sectoral and microeconomic performances.

The findings on labour and capital productivity reflect the other side of the coin with respect to factor accumulation. An important fall in labour productivity growth can be observed in table 9, which reflects the strong increase in labour inputs. At the same time the increase in capital productivity, which breaks the past trend of low or even negative capital productivity, also reflects the region's extremely low level of capital accumulation.

Table 9
LATIN AMERICA: CAPITAL AND LABOUR PRODUCTIVITY IN SELECTED PERIODS, 1950-1998
(Average annual compound growth rates)

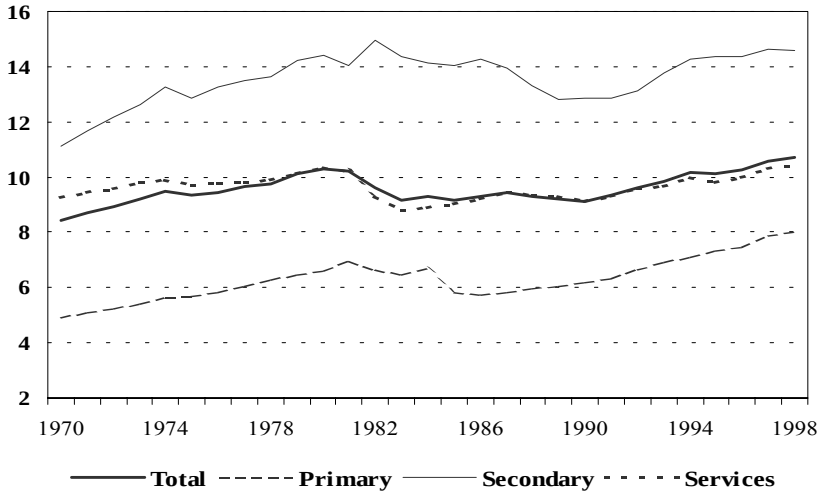
Country	Base period	post-crisis growth period	1990s	Base period	post-crisis growth period	1990s
	Labour productivity (hours worked)			Capital Productivity		
Argentina	2.5	2.9	4.3	-0.8	1.8	2.7
Bolivia	2.5	0.8	0.8	0.7	1.0	1.0
Brazil	3.9	1.0	0.4	-2.6	-0.3	-0.7
Chile	3.5	4.6	4.8	-0.3	1.3	0.9
Colombia	2.8	1.8	1.6	0.9	0.0	-0.2
Costa Rica	3.5	0.8	0.9	-0.7	-0.3	-0.6
Mexico	3.8	0.3	0.0	-1.1	0.9	0.7
Peru	2.9	1.3	1.6	-0.1	0.5	1.7
Simple Average	3.2	1.7	1.8	-0.5	0.6	0.7

Source: ECLAC, on the basis of project data.

Sectoral Productivity

It is very difficult to obtain data on capital accumulation by sector, and this makes a complete sectoral analysis of productivity and factor inputs impossible. It is, however, very important to analyse the productivity performance Latin America in more detail, in part to bridge macroeconomic analysis with more meso-or microeconomic analysis. Figures 13, 14 and 15 present labour sectoral productivity.

Figure 13
LATIN AMERICA: SECTORAL LABOUR PRODUCTIVITY, 1970-1998
(1980 international dollars)

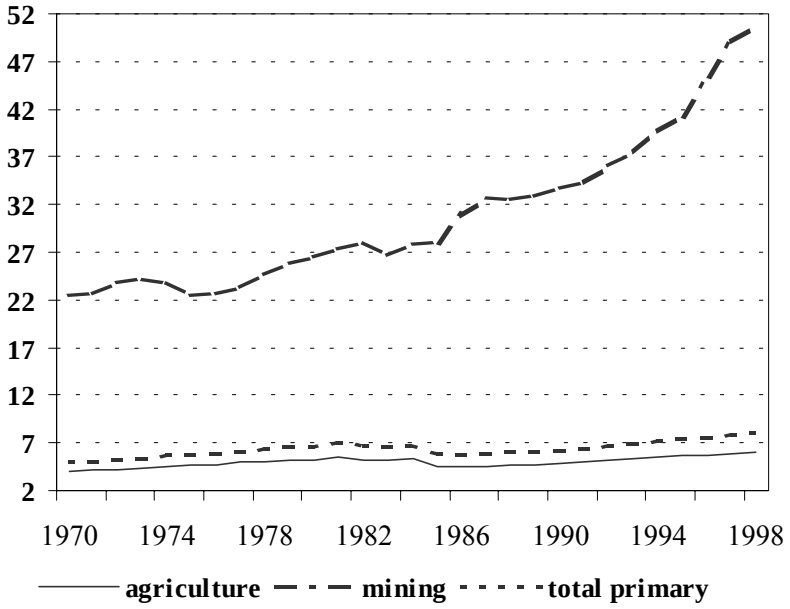


Source: ECLAC, on the basis of project data.

Figure 13 desaggregates total productivity into the three main sectors, namely, the primary, secondary and services sectors. Overall productivity increased steadily in the 1970-1980 period, fell sharply at the beginning of the 1980s, remained at that same level throughout the 1980s and then started to grow again in the 1990s. The main component of this fall constituted the services sector. Primary and secondary sector productivity showed a slightly different tendency, with a fall later in the 1980s.

Figure 14 depicts the labour productivity of the primary sector. As the figure clearly indicates, mining productivity rose very fast from the middle of the 1970s, with only a slight dip in the early 1980s. Agriculture experienced a fall in 1982-1983, but otherwise productivity rose steadily over the whole 1970-1998 period.

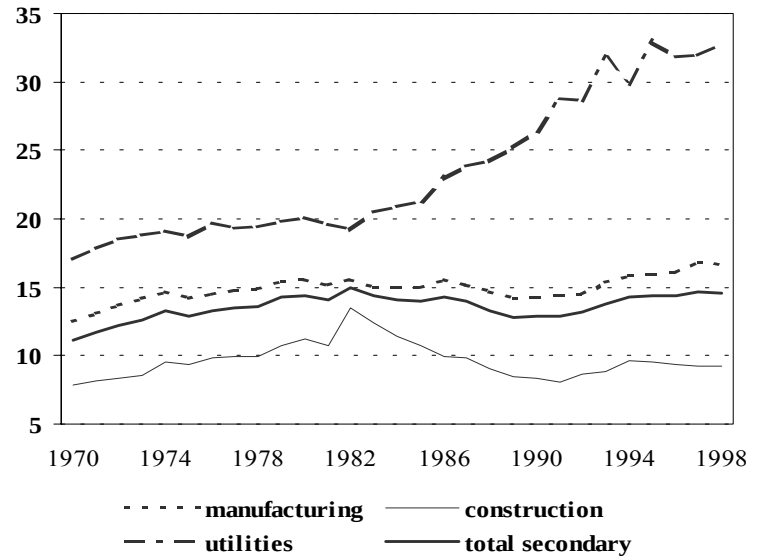
Figure 14
LATIN AMERICA: LABOUR PRODUCTIVITY IN THE PRIMARY SECTOR, 1970-1998
(1980 international dollars)



Source: ECLAC, on the basis of project data.

In the secondary sector, productivity increased in manufacturing, construction and utilities until 1982 (see Figure 15). After that date, the utilities sector grew rapidly, more than doubling its productivity level, while at the same time the level of productivity in construction fell substantially. Manufacturing shows mixed results: stagnation and declines characterized the 1980s, but after 1990 labour productivity steadily increased, and the 1998 productivity level was somewhat higher than the previous peak.

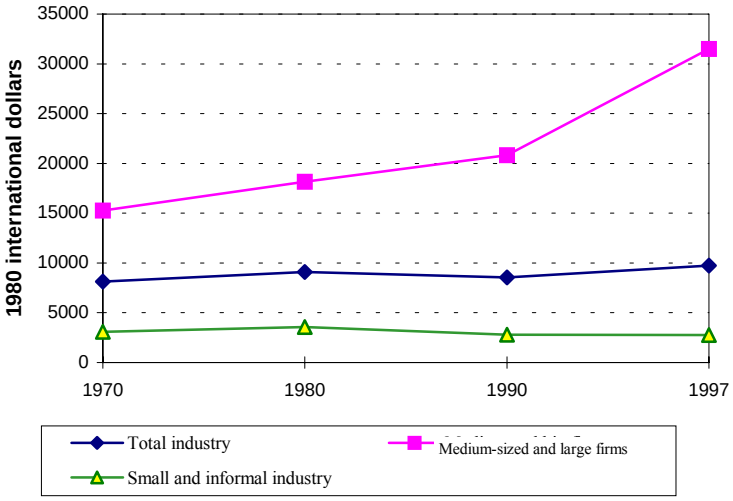
Figure 15
LATIN AMERICA: LABOUR PRODUCTIVITY IN THE SECONDARY SECTOR, 1970-1998
(1980 international dollars)



Source: ECLAC, on the basis of project data.

Figure 16 reflects labour productivity in industry, disaggregated into medium-sized and large firms and small and informal industry. Basically, productivity gains occurred in the modern sector, while productivity in small and informal industry remained stable or fell.

Figure 16
LATIN AMERICA: LABOUR PRODUCTIVITY IN INDUSTRY, 1970-1998
(1980 international dollars)



Source: ECLAC, on the basis of project data.

Total Factor Productivity

The long-run growth rate of economies increases with gains in capital and labour productivity and, more generally, with gains in total factor productivity. In this sense the interpretation of table 10 is positive and points to a stable overall efficiency of the economy. A stable overall efficiency combined with an increase in capital accumulation could lead to higher growth rates in Latin American countries.

Table 10
TOTAL FACTOR PRODUCTIVITY IN SELECTED SUB-PERIODS
(Average annual compound growth rates)

Country	Base period	post-crisis growth period	1990s	Base period	post-crisis growth period	1990s
	Total factor productivity			Doubly augmented total factor productivity		
Argentina	1.5	2.4	4.0	0.6	1.6	3.2
Bolivia	2.0	1.2	1.2	0.9	0.0	0.0
Brazil	2.6	0.7	0.1	1.4	-0.2	-0.7
Chile	2.0	3.9	3.9	1.2	2.8	2.8
Colombia	2.4	1.2	1.1	1.4	-0.1	-0.3
Costa Rica	2.2	0.6	0.7	1.2	-0.4	-0.3
Mexico	1.8	0.9	0.7	0.5	0.0	-0.3
Peru	1.9	1.3	2.0	0.9	0.8	1.5
Simple average	2.1	1.5	1.7	1.0	0.6	0.7

Source: ECLAC, on the basis of project data.

Table 11 presents the contribution of the production factors (i.e., capital and labour) and total factor productivity (TFP) to total GDP growth. The role of TFP remained stable, explaining 39% of GDP growth in the 1990s compared to 40% in the base period. It also reflects the change observed above between capital and labour contributions to economic growth, as labour's contribution rose and capital's fell.

The interpretation of total factor productivity is still a matter of debate. The final "residual" includes advances in knowledge, and it also picks up the net error (whether positive or negative) in the other estimates, as well as the net contribution of other sources of growth for which no estimation was attempted. Here, the step-by-step approach was followed, starting with the measurement of total factor productivity, including quantities of factor inputs and doubly augmented total factor productivity, which includes the quality improvement of the factor inputs. The doubly augmented total factor productivity can be considered an approximate measure of the effect of disembodied technical progress on long-term growth, but it also includes other unmeasured influences and statistical and other errors.

This analysis of productivity generates a preliminary idea of the contribution of capital and labour to economic growth and make an assessment of the relative importance of technical progress in economic growth before and after the reform period. Recent growth models suggest that countries that are more open to the rest of the world exhibit a faster rate of technological

improvement and productivity growth than countries that are isolated (Edwards, 1995). This means that these countries should experience an increase in the growth of total factor productivity.

Table 11
CONTRIBUTION OF PRODUCTION FACTORS AND TOTAL FACTOR PRODUCTIVITY TO GDP GROWTH
(Percentage of total GDP growth)

Country	Base period			Post-crisis growth period			1990s		
	Labour	Capital	TFP	Labour	Capital	TFP	Labour	Capital	TFP
Argentina	18	43	39	24	30	45	9	23	68
Bolivia	19	24	57	49	23	28	49	23	28
Brazil	31	32	37	35	36	29	47	45	8
Chile	7	41	52	21	27	51	21	29	51
Colombia	24	29	47	26	41	32	27	43	29
Costa Rica	25	41	34	56	31	13	44	38	18
Mexico	19	53	28	32	39	29	35	42	22
Peru	23	38	39	40	28	32	37	20	42
Simple average	21	38	42	35	32	32	35	32	33

Source: ECLAC, on the basis of project data.

IV. CONCLUSIONS

1. One of the most important conclusions of this analysis is that it is very difficult to discern a general tendency in the different variables. Latin American countries are increasingly heterogeneous; not only with regards to total GDP or per capita GDP but also, and probably even more, so the case of other variables such as capital formation. Therefore, the use of averages, whether simple or weighted, is misleading. Simple averages increase the importance of the small countries, while weighted averages give much more importance to bigger countries such as Brazil and Mexico.

2. The post-crisis period shows somewhat lower growth (around 4% annually) as compared to the base period (5%). This tendency is more marked when a weighted comparison is made, revealing a radical change in the composition of low-and high-growth countries. Most of the fastest growing countries in the pre-crisis period are now among the slowest growing ones.

3. All countries except Brazil experienced an increase in labour accumulation. With respect to capital accumulation, the opposite trend occurred: capital accumulation fell in most countries, with the exception of Bolivia and Chile.

4. The growth rate of labour productivity fell in the post-crisis period, especially in Costa Rica and Mexico. Capital productivity rose in all countries except Colombia, but it is to be expected that capital productivity growth will fall in the future.

5. With respect to the role of total factor productivity, this study found that the annual compound growth rate remained stable, at around 2%, comparing the base period and the post-crisis growth period. The contribution of total factor productivity to total GDP growth also remained stable, at around 40%, over the same periods.

6. Analysis based on a growth-accounting framework indicates that future growth will benefit from an increase in capital accumulation, within the context of a relatively high overall efficiency of the economies.

7. With respect to tendencies regarding heterogeneity among countries, some degree of convergence took place in Latin America during the base period. However, the post-crisis period saw increasing levels of heterogeneity among the countries.

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APPENDIX

Methodological note

This appendix presents a brief formalization of the model used in this paper and the derivation of the four total factor productivity variants that were estimated. It also gives a description of the basic data used in the model.

Model

In this growth-accounting exercise, a simple Cobb-Douglas function was applied.

$$Y = A\,L^{\alpha}\,K^{(1-\alpha)} \qquad (1)$$

Where Y represents GDP, L labour, K capital, A technical progress and α the factor share of labour. In its logarithmic version:

$$\ln Y = \alpha\, lnL + (1-\alpha)\, lnK + A \qquad (2)$$

In the case of the capital and labour production factors, the quantity and quality of inputs were considered. The physical increase in labour was estimated by the increase in the amount of hours worked and the quantity increase in capital by fixed capital formation. The increase in the quality of labour was estimated through the educational level of the population, measured as the growth rate of the years of education, in the case of the capital stock, increased quality was measures through a vintage effect.

Having incorporated these effects four different measures of total factor productivity (TFP) can be differentiated. Equation (3) presents the most elaborate version in which L represents labour quantity (hours), l labour quality (education), K physical capital stock and k the vintage effect of capital:

$$\ln Y = \alpha \ln(L+l) + (1-\alpha)\ln(K+k) + A \qquad (3)$$

The 4 TFP estimates are as follows (in a simplified annotation with growth rates, g):

- Only the physical increases in capital and labour.

$$A1 = g_Y - \alpha g_L - (1-\alpha) g_K \qquad (4)$$

- The physical effects plus the quality effect of capital (capital-augmented joint factor productivity).

$$A2 = g_Y - \alpha g_L - (1-\alpha) g_{(K+k)} \qquad (4)$$

- The physical effects plus the quality effect of labour (labour-augmented joint factor productivity).

$$A3 = g_Y - \alpha g_{(L+l)} - (1-\alpha) g_K \qquad (5)$$

- The physical effects plus the quality effects of both labour and capital (doubly augmented joint factor productivity).

$$A4 = g_Y - \alpha g_{(L+l)} - (1 - \alpha) g_{(K+k)} \qquad \textbf{(6)}$$

Data

GDP

Gross domestic product (GDP) at market prices was used as the output measure because it is the most easily available aggregate for comparative purposes and is also widely used in growth accounting (see Maddison [1987] for a comparison of different output measures used in growth accounting studies). The series used for Latin America are derived from currently collected official estimates by ECLAC corresponding to the most recent revision of the United Nations System of National Accounts (SNA).

To compare levels of output, capital, per capita income and productivity in different countries, it is useful to have a unit that expresses the comparative value of their currencies better than exchange rates. The latter reflect purchasing power over tradable goods and services, and they are subject to a good deal of fluctuation as a result of capital movements. This study used the results of Phase IV of the United Nations International Comparison Project, which generated purchasing power parities (PPP) for GDP and the different types of capital formation. The PPPs were expressed in "international dollars" obtained by applying a common set of prices, representative of the world price structure, to the quantities of the commodities and services entering into each country's final expenditure on GDP. The PPPs for Latin America were provided by Alan Heston of the University of Pennsylvania and former director of the ICP. These PPPs differ somewhat from the ones published in United Nations/EUROSTAT (1987), which contained some computational errors.

Employment[1]

Analysing the labour market in Latin America requires some basic quantification. Many institutes are working on this theme, both regionally, like the former PREALC, and in the different countries. A general source note is given which presents the data bases and other general information used in common for all countries. Male and Female activity rates for 1950-1980 are from ECLAC (1985). These activity rates were calculated on the basis of population censuses and household surveys. However, the CELADE population figures are adjusted for undercounting in the censuses, especially for males. This adjustment causes small changes in total activity rates. ECLAC's sex-specific activity rates for the respective population was used to calculate the total activity rate. For 1990 population censuses were used when available. For Brazil and Colombia CELADE (1992) was used. The employment rates for 1950-1980 are from the ECLAC Projections Center and are based on population censuses. The 1990 estimate was

[1] For a more detailed presentation of the employment data, see Hofman (2000).

calculated by the author using population censuses. Annual hours per person employed was calculated on the basis of the number of days worked per year and the average number of hours worked per day. Number of days worked during the year was calculated on the basis of public and statutory holidays from ILO (1982) and estimated for missing years.

The estimates for average years of formal education of the population between 15 and 64 years of age were estimated on the basis of the population censuses of the countries. In many cases the census information had to be adjusted, which in generally was been done as follows: if the census data only presented educational level of people 15 years and older, information from previous censuses was used to estimate the cohort 65-75, the census which was then used to adjust information. If information within the 50-64 group was lacking, we tried to apply the same procedures. We adjusted for differences in the number of years, especially for primary and secondary education: the first six years were considered primary education, and the second six years secondary education. If, for example, Argentina has 7 years of primary education and 5 years of secondary than, we considered the seventh year of primary as the first year of secondary. If census data were not available, national sources, the World Bank data base on capital stock, which was kindly provided to us by the World Bank, or estimates by Maddison (1989) were used.

Capital

A model layout for capital stock estimation was developed to make all procedures transparent and to facilitate the replication of these results by other researchers.

The initial year-end gross capital stock was calculated as follows:

$$GGI^i_t = a^i_t * GDP_t \qquad \textbf{(7)}$$

$$GK^i_b = \sum_{m=b-\theta^i+1}^{b} GGI^i_m \qquad \textbf{(8)}$$

Where:

GGI^i_t Gross increment to capital stock of asset *i* during period *t*
GDP_t Gross domestic product in *t*
GK^i_b Gross initial capital stock of asset *i* at *b*
A^I_t Ratio of total gross fixed investment of asset *i* to GDP at constant prices in *t*
b Initial year
θ^i Length of life of asset i
i Type of asset
t Time

Net mid-year capital stock was calculated as follows:

$$D^i_t = \frac{1}{\Theta} \sum_{m=t+1-\theta^i}^{t} GGI^i_m \qquad \textbf{(9)}$$

$$NK_b^i = \sum_{m=b-\theta^i+1}^{b} \frac{(m - b + \theta^i)}{\theta^i} * GGI_m^i \quad \textbf{(10)}$$

Where:

D_t^i Depreciation of asset *i* during period *t*
NK_b^i Net initial capital stock of asset *i* at *b*

The respective net and gross year-end capital stock series were calculated as follows:

$$GK_t^i = GK_{t-1}^i + GGI_t^i - GGI_{t-\theta}^i \quad (t > b) \quad \textbf{(11)}$$

$$NK_t^i = NK_{t-1}^i + GGI_t^i - D^{i_t} \quad \textbf{(12)}$$

Where:

GK_t^i Gross capital stock of asset *i* at *t*
NK_t^i Net capital stock of asset *i* at *t*

Finally, the formulas for total gross and net capital stock aggregation and total gross and net capital stock average age calculation are presented.

$$AAGK_t^i = \frac{\sum_{m=t-\theta^i+1}^{t} (t - m) * GGI_m^i}{GK_t^i} \quad \textbf{(13)}$$

$$AANK_t^i = \frac{\sum_{m=t-\theta^i+1}^{t} \left(\frac{m - t + \theta^i}{\theta^i}\right) * (t - m) * GGI_m^i}{NK_t^i} \quad \textbf{(14)}$$

$$GMK_t^i = \frac{GK_{t-1}^i + GK_t^i}{2} \quad \textbf{(15)}$$

$$NMK_t^i = \frac{NK_{t-1}^i + NK_t^i}{2} \quad \textbf{(16)}$$

$$TGK_t = \sum_{i=1}^{n} GK_t^i \quad \textbf{(17)}$$

$$TNK_t = \sum_{i=1}^{n} NK_t^i \quad \textbf{(18)}$$

$$AAGK_t = \frac{\sum_{i=1}^{n} AAGK_t^i * GK_t^i}{TGK_t} \quad \textbf{(19)}$$

$$AANK_t = \frac{\sum_{i=1}^{n} AANK_t^i * NK_t^i}{TNK_t} \quad \textbf{(20)}$$

Where:

$AAGK_t$:	Average age of gross capital stock of asset *i* in *t*
$AANK^i_t$:	Average age of net capital stock of asset *i* in *t*
GMK_t:	Gross capital stock, mid-year *t*
NMK_t:	Net capital stock, mid-year *t*
TGK_t:	Total gross capital stock in *t*
TNK_t:	Total net capital stock in *t*
$AAGK_t$:	Average age of total gross capital stock in *t*
$AANK_t$:	Average age of net capital stock in *t*
N:	Number of assets *i*

Factor Shares

Factor shares are necessary in the calculation of total factor productivity, as each factor input has to be weighted by its respective factor share. The factor weights used in growth accounting affect the results of the exercises substantially, because rather big differences exist in growth rates of labour and capital stocks. The three main components of GDP are fixed capital consumption, employee compensation and operating surplus. This last component must be divided between capital, labour and land income.

In Latin America, much more than in the developed countries, an important part of the operating surplus consists of labour compensation for the self-employed. These earnings have to be attributed to labour's share. The total capital share has been disaggregated into the capital shares of its three components, namely, residential capital, non-residential capital and machinery and equipment. In some growth-accounting exercises, the individual items in the capital stock are weighted at their total stock value. However, the service flow per unit of capital in machinery and equipment is much higher than from a unit of residential capital. Therefore, the components of the capital stock have been weighted by their asset life, and the resulting disaggregated capital stock shares were multiplied by the national accounts total capital share. For the standardized capital shares, the disaggregation found in Maddison (1991) has been used. For land income, which was used as a proxy for natural resource endowment, it was impossible to obtain estimates for all countries, and a 10% share was assumed for the whole period based on national accounts estimates available for some years.

Notes

[1] For much of the analysis, data were not available for Jamaica; the country is included whenever possible, however.
[2] These averages relate to Latin America as a whole; our sample countries have a lower average (35%) because the Southern Cone countries have much lower levels (especially Chile).
[3] In this paper all variables are calculated on the basis of constant prices, although in the case of investment the measurement in current prices would be more adequate.
[4] This measure obviously depends also on GDP growth. For example, if capital formation remains constant but GDP falls, capital formation as a percentage of GDP rises, while the capital stock, which reflects productive capacity, remains constant or falls depending on retirement and depreciation patterns.