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Business Cycles in South America and East Asia: An Introduction

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ABSTRACT: We study the business cycle component of the per capita gross domestic product of ten South American and six East Asian countries during the period 1970-2000. Both sets of countries display an average volatility roughly equal to twice the U.S. one. Average persistence in each of these areas is similar to the U.S. The cyclical phases usually do not coincide temporally across countries.

Key-words: business cycles, South America, East Asia

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I. MEANINGS OF THEORIES

The essay *Time to build and aggregate fluctuations* by Kydland and Prescott (1982) had a profound impact on macroeconomic theory. The relevance of their groundbreaking work was recognized when they won the 2004 Nobel Prize for economics.

Kydland and Prescott (1982) implemented a methodology that subsequently became standard. They constructed a dynamic and stochastic general equilibrium model. Then they used numerical methods to compute the solution to this model, that is, mathematical relations that described the temporal path of the endogenous variables as functions of the parameters, the initial conditions and the realizations of the random variables. Finally, they compared the statistical properties of the series generated by the model with equivalent series in the real world.

The methodology employed by Kydland and Prescott has become quite popular among researchers in the area of macroeconomics. It has been used to study a wide range of questions. For example, Mendonza (1991) and Backus, Kehoe and Kydland (1992) used it to study economic cycles in models of open economies. Chari, Kehoe and McGrattan (2000) utilized similar procedures to verify whether monetary shocks in a general equilibrium model with rigid prices are able to generate economic cycles with persistence similar to those observed in the United States.

For the method Kydland and Prescott to be implemented, there evidently must be information on the statistical properties of the macroeconomic series. For this reason, Kydland and Prescott (1990, p. 3) affirmed that "reporting facts – without assuming that the data are generated by some type of probabilistic model – is an important scientific activity."

Various texts have been dedicated to the statistical properties of macroeconomic variables. For example, Backus and Kehoe (1992) documented some characteristics of series, such as gross national product (GNP), aggregate investment and price level for countries of the Organization for Economic Cooperation and Development (OECD) in the period 1850-1986. Baxter and Stockman (1989), using a sample of forty-nine countries, studied whether the volatility and correlation of some macroeconomic variables are dependent on the exchange rate regime. Ambler, Cardia and Zimmermann (2004) used econometric techniques to estimate the correlations between diverse macroeconomic variables of twenty industrialized countries.

This essay fits in the line of research described in the paragraph above. It has the modest objective of documenting some properties of the business cycles in ten South American countries (Argentina, Bolivia, Brazil, Chile, Colombia, Ecuador, Paraguay, Peru, Uruguay and Venezuela), six East Asian countries (Singapore, South Korea, Hong Kong, Indonesia, Malaysia and Thailand), and for comparison purposes, the United States, in the period 1970-2000.

We reached several conclusions in this work. We found that the cyclical fluctuations in East Asia and South America are more volatile than those observed in the United States. More specifically, the standard deviation of the cyclical component of per capita GDP (Gross Domestic Product)[1] of developing countries is, on average, twice that in the United States.

[1] GDP measures the output of goods and services within a country's borders, while GNP measures the output of the nation's factors of production regardless of whether they are located within its borders. The important distinction between GDP and GNP rests on differences in counting production by foreigners in a country and by nationals outside of a country. A country's GNP can thus either be larger or smaller than its GDP depending on

Additionally, when taken individually, each of the developing nations has greater volatility than does the U.S.

On average, the cyclical swings in South America and East Asia are slightly more persistent than in the U.S. In some countries, however (such as Argentina and Hong Kong), the cyclical variations are less persistent than in the U.S.

Except for Brazil and Hong-Kong, the business cycles in South American and East Asian countries have a low correlation with those in the United States. The respective mean correlation coefficients for those two regions were 0.04 and –0.07. These statistics are quite distant from the equivalent ones found by Backus and Kehoe (1992) for nine developed countries.

We also carried out an exercise to date the cyclical business phases. In other words, we checked year-by-year whether each of the countries studied was in recession or expansion. We concluded that there is no propensity for the countries to show the same timing in their business cycles. This finding is valid even when the exercise is restricted to countries of a single continent.

The rest of this work is organized as follows. In Section 2 we present a simple procedure to implement the popular Hodrick-Prescott (HP) filter. In Section 3 we analyze the properties of economic cycles of the countries in the sample. We present our conclusions in Section 4. After the references, the Appendix contains graphs that depict the behavior of per capita GDP in the nations included in the sample.

II. THE HODRICK-PRESCOTT FILTER

A temporal series y_t can be decomposed into trend components y_t^T and cycle components y_t^C. Obviously, the original series and its components must satisfy the equality $y_t = y_t^T + y_t^C$.

There are various ways to perform the decomposition mentioned above. One of the most popular is to use the Hodrick-Prescott (HP) filter, which we did in this work.

The HP filter was first presented in a working paper by Hodrick and Prescott (1980). It took 17 years for this work to be published in an updated version – Hodrick and Prescott (1997).

Despite the delay in official publication of the original work, the HP filter became extremely popular among researchers studying economic cycles. Kydland and Prescott (1982), Backus and Kehoe (1992) and Ellery, Gomes and Sachsida (2002) are typical examples of works that have used this filter.

We present here a procedure to compute the HP filter. Let y_t be the natural logarithm of the real per capita GDP of some country. Given N observations of this variable, its trend y_t^T is then chosen so as to minimize the function

$$F(y_1^T, y_2^T, \ldots, y_N^T) = \sum_{t=1}^{N} (y_t - y_t^T)^2 + \lambda \sum_{t=2}^{N-1} \left[(y_{t+1}^T - y_t^T) - (y_t^T - y_{t-1}^T) \right]^2 .$$

It can be seen that that because it is a sum of squares, F must be non-negative.

The function F has two components. The first is given by the deviation of the observed product y_t from the trend y_t^T. The second corresponds to the variation in growth of the trend

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the number of its citizens working abroad versus the number of foreign workers within its borders. Despite these differences, the two measures are sufficiently close that the comparisons made here between our results and those of authors using GNP are still valid.

y_t^T. For the first summation to be nil, the trend must be equal to the effective product. For the second summation to be nil, the first difference of the trend must be constant. Hence, if the first difference of the per capita product is not constant, it will not be possible for both summations to be nil.

The arguments developed in the preceding paragraphs illustrate the underlying procedure of the HP filter. The trend y_t^T must be chosen so as to obtain a compromise between two targets: (1) a small difference between the observed product and the trend; and (2) smooth growth of the trend. The smoothing parameter λ defines the relative weight attributed to the two targets. The greater the value of λ is, the smoother the growth of the trend will be.

Following the procedure employed by Backus and Kehoe (1992) and Ellery, Gomes and Sachsida (2002), we adopted in this essay a value of 100 for the parameter λ. Although there is no consensus among authors, this is the value usually utilized for data with annual frequency. A detailed discussion of the choice of the value of λ can be found in Ravn and Uhlig (1997).

The first-order conditions to minimize F are

$$(1+\lambda)y_1^T - 2\lambda y_2^T + \lambda y_3^T = y_1 \;;$$
$$-2\lambda y_1^T + (1+5\lambda)y_2^T - 4\lambda y_3^T + \lambda y_4^T = y_2 \;;$$
$$\lambda y_{t-2}^T - 4\lambda y_{t-1}^T + (1+6\lambda)\, y_t^T - 4\lambda y_{t+1}^T + \lambda y_{t+2}^T = y_t,\; t = 3,4,\ldots, N-2 \;;$$
$$\lambda y_{N-3}^T - 4\lambda y_{N-2}^T + (1+5\lambda)\, y_{N-1}^T - 2\lambda y_N^T = y_{N-1} \;;$$
$$\lambda y_{N-2}^T - 2\lambda y_{N-1}^T + (1+\lambda) y_N^T = y_N \,.$$

The above system can be rewritten as

$$\mathbf{A}\begin{bmatrix} y_1^T \\ \vdots \\ y_N^T \end{bmatrix} = \begin{bmatrix} y_1 \\ \vdots \\ y_N \end{bmatrix},$$

where **A** is an $N \times N$ matrix. The first two and last two rows of **A** are given by

$$a_1 = [1+\lambda, -2\lambda, \lambda, 0, \ldots, 0];$$
$$a_2 = [-2\lambda, 1+5\lambda, -4\lambda, \lambda, 0, \ldots, 0];$$
$$a_{N-1} = [0, \ldots, 0, \lambda, -4\lambda, 1+5\lambda, -2\lambda];$$
$$a_N = [0, \ldots, 0, \lambda, -2\lambda, 1+\lambda];$$

while the coefficients of the other rows are given by

$$a_{ij} = \begin{cases} 0 & \text{se } |i-j| > 2, \\ \lambda & \text{se } |i-j| = 2, \\ -4\lambda & \text{se } |i-j| = 1, \\ 1+6\lambda & \text{se } |i-j| = 0. \end{cases}$$

Thus, the trend y_t^T can be computed according to

$$\begin{bmatrix} y_1^T \\ \vdots \\ y_N^T \end{bmatrix} = \mathbf{A}^{-1}\begin{bmatrix} y_1 \\ \vdots \\ y_N \end{bmatrix}.$$

Given the trend y_t^T, the cyclical component y_t^C can be evaluated by the difference $y_t - y_t^T$.

III. ECONOMIC CYCLES IN SOUTH AMERICA AND EAST ASIA

In this work we used the annual per capita GDP series for the United States, ten South American countries (Argentina, Bolivia, Brazil, Chile, Colombia, Ecuador, Paraguay, Peru, Uruguay and Venezuela) and six from East Asia (Singapore, South Korea, Hong Kong, Indonesia, Malaysia and Thailand). The sample covers the period 1970-2000.

We obtained data on the GDP of each country from the CD *International Financial Statistics* from the IMF. Information on the population of the various countries was available at the Internet page of the U.S. Census Bureau. Based on these data, we constructed the per capita GDP series for each country.

The principal factor determining the choice of the data's frequency, the period and the countries analyzed was availability. The use of monthly or quarterly data and/or the extension of the sample study period would have meant excluding some countries. Likewise, the inclusion of more countries would have meant the reduction of the period studied. We sought a compromise between detail and scope of the sample, choosing the period and group of countries mentioned at the start of this section.

We present in the Appendix two graphs for each of the countries studied. The first graph of each pair plots the trajectory of the logarithm of the real per capita GDP y_t and its trend y_t^T. The second depicts the evolution of the cyclical component y_t^C.

The United States, Colombia, Uruguay and the East Asian countries presented nearly linear trends, unlike the other South American countries. The trend curves for Argentina, Bolivia and Peru exhibited sinusoidal behavior. Brazil, Ecuador and Paraguay had growth trends until 1980 and stagnation thereafter. The Chilean economy was stagnant until 1980 and ascendant from 1981 onward. Finally, Venezuela had a rising trend until 1977, descended from 1978 until 1987 and was flat from 1988 onward.[2]

A quick analysis of the graphs of the cyclical components of per capita GDP suggests that the statistical properties of the series y_t^C are not homogenous among the countries studied. For example, the cycles are apparently more persistent in Bolivia than in Argentina. Such heterogeneity is documented in the discussion that follows.

Among the many attributes of business cycles, three are usually studied in more detail. These are *volatility*, *persistence* and degree of *comovement* of the variables. The volatility of an economy's cycles is normally measured by the standard deviation of y_t^C. The persistence is measured by the correlation coefficient of y_t^C with y_{t-1}^C. Finally, the degree of comovement of the cyclical component of per capita GDP with some variable of interest is given by the correlation coefficient of y_t^C with this other series.

Table 1 contains the statistics on volatility and persistence of the business cycles for each country studied, along with the degree of comovement of these national economies with the United States'. The lines referring to South America and East Asia present the simple arithmetic means of the respective regions.

[2] The long-term growth differential among countries of South America and East Asia has been the subject of various studies. We suggest that readers wanting a better understanding of this question consult De Gregorio and Lee (2003) and Ferreira, Pessoa and Veloso (2004).

Table 1 – Descriptive statistics of economic cycles

Country	Volatility	Persistence	Co-movement with the USA
USA	2.13	0.54	1.00
South America	4.36	0.63	0.04
Argentina	4.46	0.42	-0.09
Bolivia	3.40	0.86	-0.04
Brazil	3.67	0.62	0.43
Chile	6.21	0.59	0.13
Colombia	2.45	0.67	0.11
Ecuador	4.20	0.51	0.02
Paraguay	4.06	0.63	-0.16
Peru	6.01	0.78	0.07
Uruguay	4.73	0.65	0.01
Venezuela	4.41	0.61	-0.07
East Asia	3.94	0.56	-0.07
Singapore	3.48	0.55	-0.11
South Korea	3.37	0.48	0.15
Hong Kong	3.41	0.38	0.30
Indonesia	4.18	0.58	-0.26
Malaysia	4.18	0.62	-0.34
Thailand	4.99	0.72	-0.17

Fonte: cálculo dos autores.

The average volatility of South America (4.36%) is slightly higher than in East Asia (3.94%). Both means are markedly greater than the volatility in the United States (2.13%).

Among all the developing countries included in the sample, the smallest volatility observed is in Colombia (2.45%). This figure exceeds the volatility for the United States, so each South American and East Asian country individually has less volatile cycles than in the United States.

The greater volatility of business cycles in developing countries becomes even more evident when the results obtained in this study are compared with those of Backus and Kehoe (1992). These authors documented the statistical properties of business cycles in ten developed countries (West Germany, Australia, Canada, Denmark, United States, Italy, Japan, Norway, United Kingdom and Sweden). Particularly, for periods in the neighborhood of 1950-1985,[3] the volatility of these countries' GNP was equal to 2.06%, with the highest figure observed being 3.11% for Japan. Except for Columbia and the United States, all the countries studied here had volatility above 3.11%.

The mean persistence of 0.56 observed for East Asia is slightly higher than the corresponding value of 0.54 for the United States. In South America, the mean of this statistic

[3] The period studied had small differences according to the country analyzed. The starting year varied from 1950 to 1952 and the ending from 1983 to 1986. The exact period for each country is detailed in the note to Table 1 of Backus and Kehoe (1992).

is 0.63. It is worth noting that Argentina (0.42), Ecuador (0.51), South Korea (0.48) and Hong Kong (0.38) presented less persistent cycles that those in the United States.

The mean coefficients of comovement for South America and East Asia with the United States are, respectively, 0.04 and –0.07. These numbers are very near zero. Hence, one can affirm that on average the economic cycles of the countries of these regions are not related to those in the United States.

Brazil has a correlation coefficient with the Unites States of 0.43, the largest value observed in the sample. Hong Kong, with a statistic of 0.30, also has a relatively high value. All the other countries have a comovement level less than or equal to 0.15.

The low correlation of the economic cycles in countries of South America and East Asia with those in the United States becomes even more evident when the results of Backus and Kehoe (1992) are considered. For periods in the neighborhood of 1950-1985,[4] the data presented by these authors permitted them to conclude that the mean correlation of the cycles in the U.S. with those of the nine other countries they studied was equal to 0.30. The correlation coefficients of Australia and Sweden were, respectively, 0.10 and –0.10. Each of the other seven countries presented a level of comovement greater than or equal to 0.15, with some values as high as 0.51 (Japan) and 0.64 (Canada).

An economy is said to be in *expansion* at date t when the cyclical component of per capita GDP is growing, i.e, $y_t^C - y_{t-1}^C > 0$. Similarly, an economy is in *recession* at date t when $y_t^C - y_{t-1}^C \leq 0$. There is an *inflection point* at date t-1 when the economy was in recession (expansion) at t-1 and is in expansion (recession) at t. In other words, an inflection point corresponds to a change in the business cycle phase.[5]

Researchers and policymakers place great weight on the concepts of expansion and recession. For this reason, we present in Table 2 a detailed description of the evolution of these phases of the economic cycle for each of the countries studied.

[4] See the previous footnote.

[5] The paper by Canova (1999) contains a detailed treatment of the problem of identifying the phases and inflection points of business cycles.

Table 2 – Phases of economic cycles

Year	USA	South América										East Asia					
		AR	G	BOL	BR	A	CHI	COL	ECU	PAR	PER	SIN	KOR	HK	IND	MA L	THA
1971																	
1972																	
1973																	
1974																	
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2000																	

Remark “” and “” denote expansion and recession, respectively.
Source: Calculated by the authors.

A marked characteristic of Table 2 is the lack of homogeneity of the cyclical phases among the countries. Only in one of the years studied (1982) were all the countries in the same phase (recession).

It is possible that this anomalous outcome of uniform recession in 1982 is related to three shocks occurring in that period. In January 1979 the Fundamentalist Revolution overthrew the Shah of Iran and in September that year the war between Iran and Iraq broke out. These events together constitute what is known as the second oil shock. In November 1979, the U.S. Federal Reserve began a process of monetary tightening. Subsequently, in August 1982, Mexico declared a moratorium on its external debt. A financial crisis then began which was to affect many developing countries.

Various authors have held the set of events narrated above responsible for the worldwide economic slump observed in 1982. For example, Cardoso and Helwege (1992) and Fishlow (1986) emphasized the effects of higher interest rates, oil shocks and the debt crisis of 1982 on developing countries.

Considering only the countries of East Asia, it is possible to identify some years in which common cyclical phases occurred in all of them. In 1973, 1994 and 2000 all six countries were expanding, while in 1975, 1982, 1985 and 1998 all were in recession.

Usually the occurrence of a currency crisis is accompanied by an economic downturn. Evidence of this is presented in various works, such as Frankel and Rose (1996) and Milesi-Ferreti and Razin (1998). So, it is natural to associate the recession in East Asia in 1998 to the currency crisis of 1997.[6]

In 1997 there was common expansion in all the South American countries, while in 1999 all the economies of that region were in recession. Outside those two years, however, there is no other moment when all the economies of South America were moving in lockstep.

Apparently, there is no propensity for any year to be characterized by common recession or expansion for all the countries in the sample. Even when restricting this type of exercise to just the countries of South America or East Asia, the result is the same.

This non-coincidence of the economic cycle phases occurs even when analyzing pairs of countries. In other words, it is not possible to find two countries from among the seventeen in the sample whose economic cycles were in phase throughout the study period (1971-2000).

Three main conclusions emerge from the analysis developed in this section. First, the business cycles in South America and East Asia are much more volatile and slightly more persistent than those in the United States. Besides this, there is a very low correlation between the economic activity of these countries and that in the U.S. Finally, countries on the same continent do not present business cycles coinciding in time.

IV. FINAL CONSIDERATIONS

Various texts have sought to document the empirical regularities of business cycles. Following this line of research, the present essay studied the properties of the cyclical component of per capita GDP of ten South American countries, six East Asian ones and the United States in the period 1970-2000.

All the developing nations considered had more volatile cycles than in the United States. On average, both in South America and East Asia the cycles were roughly double those in the U.S.

The business cycles of South America and East Asia were, on average, slightly more persistent than those in the United States. Nevertheless, some countries of those regions presented less persistent cycles than in the U.S.

In general, the correlation of the economic cycles in South American and East Asia with cycles in the United States was low. In particular, the values observed in this study were much smaller than the corresponding numbers for developed countries.

[6] Note that the existence of a correlation between currency crises and recessions does not necessarily imply a cause and effect relationship.

The countries studied presented very different timings of their business cycles. We did not find any tendency for the countries of South America to experience recessions or expansions on homogenous dates, the same being true for East Asia as well.

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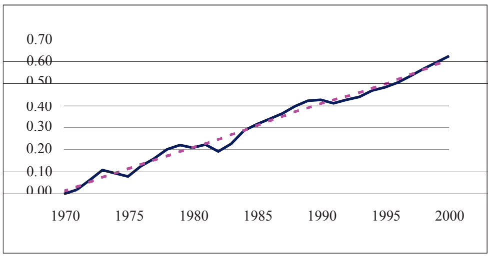
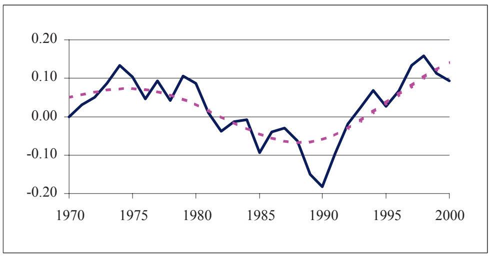
Appendix

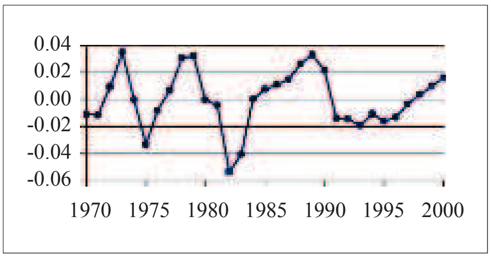
Graph 1
Per capita GDP of the
USA: effective and trend



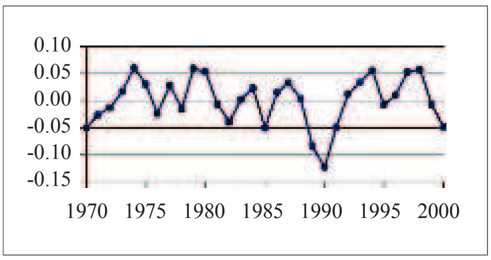
Graph 3
Per capita GDP of
Argentina: effective and trend



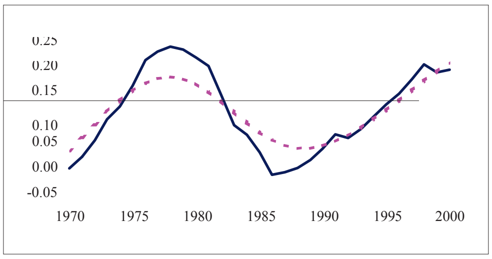
Graph 2
Per capita GDP of the
USA: cyclical component



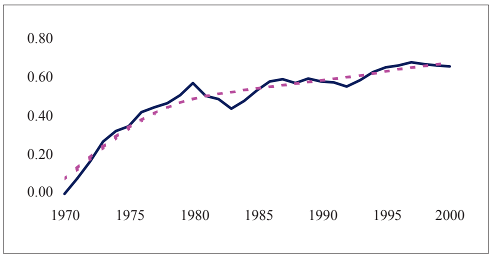
Graph 4
Per capita GDP of
Argentina: cyclical component



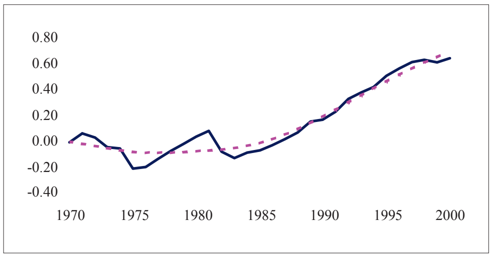
Graph 5
Per capita GDP of
Bolivia: effective and trend



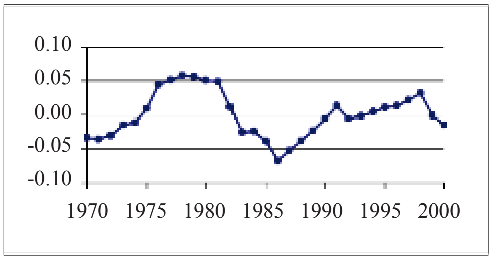
Graph 7
Per capita GDP of
Brazil: effective and trend



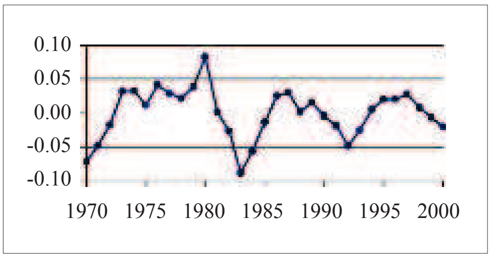
Graph 9
Per capita GDP of
Chile: effective and trend



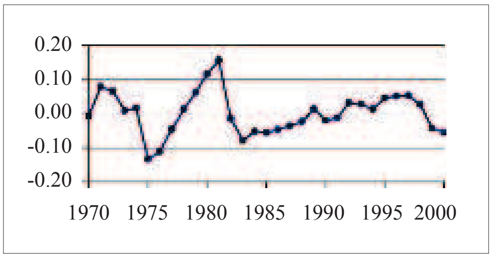
Graph 6
Per capita GDP of
Bolivia: cyclical component



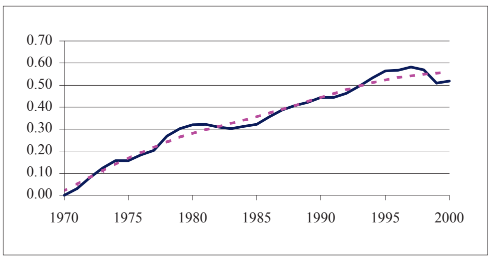
Graph 8
Per capita GDP of
Brazil: cyclical component



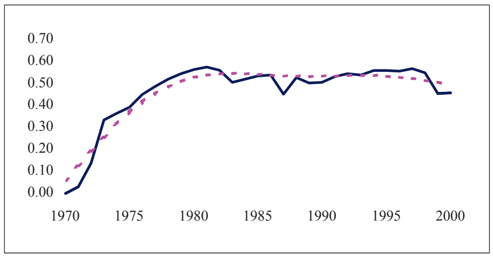
Graph 10
Per capita GDP of
Chile: cyclical component



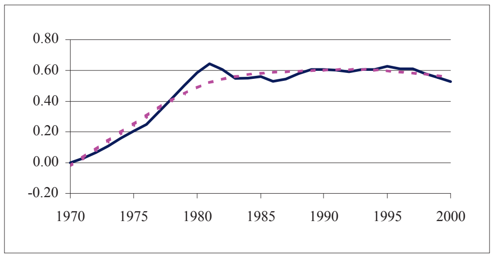
Graph 11
Per capita GDP of
Colombia: effective and trend



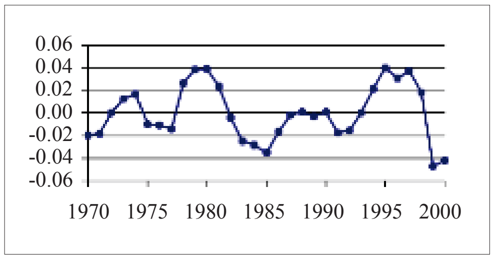
Graph 13
Per capita GDP of
Ecuador: effective and trend



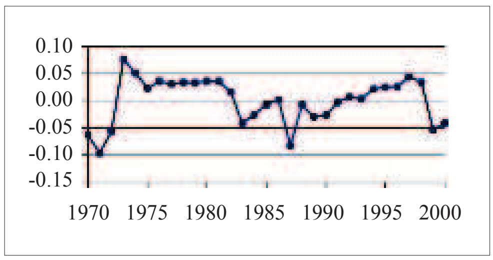
Graph 15
Per capita GDP of
Paraguay: effective and trend



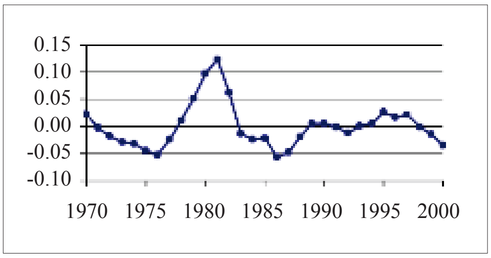
Graph 12
Per capita GDP of
Colombia: cyclical component



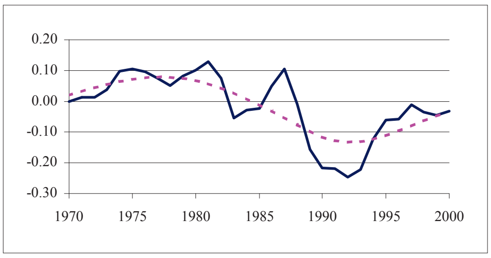
Graph 14
Per capita GDP of
Ecuador: cyclical component



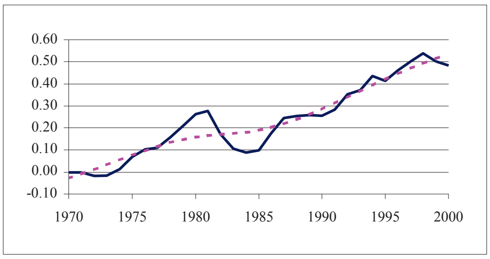
Graph 16
Per capita GDP of
Paraguay: cyclical component



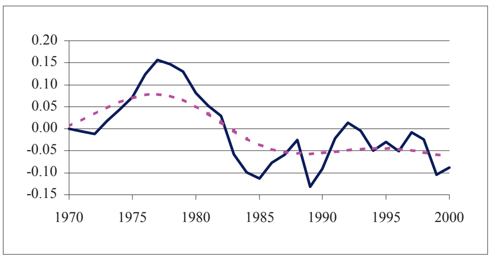
Graph 17
Per capita GDP of
Peru: effective and trend



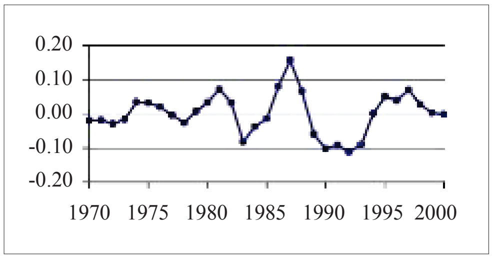
Graph 19
Per capita GDP of
Uruguay: effective and trend



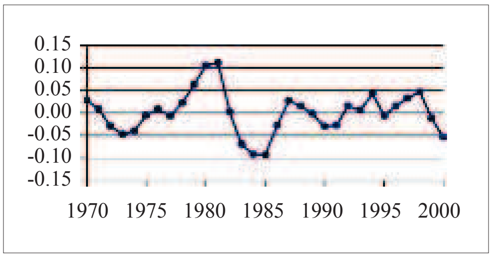
Graph 21
Per capita GDP of
Venezuela: effective and trend



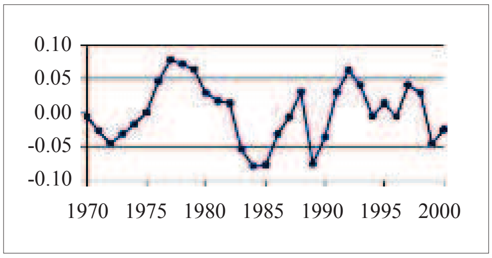
Graph 18
Per capita GDP of
Peru: cyclical component



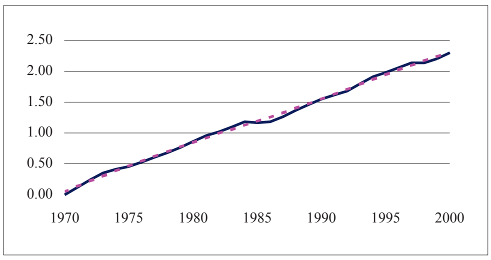
Graph 20
Per capita GDP of
Uruguay: cyclical component



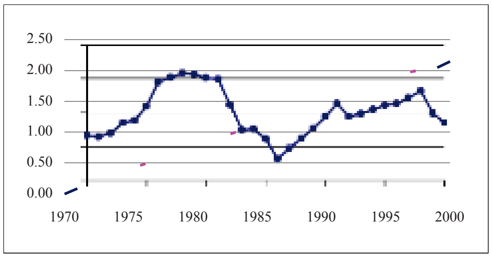
Graph 22
Per capita GDP of
Venezuela: cyclical component



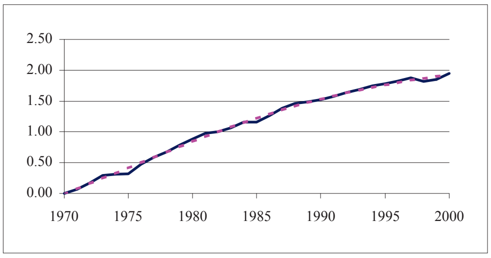
Graph 23
Per capita GDP of
Singapore: effective and trend



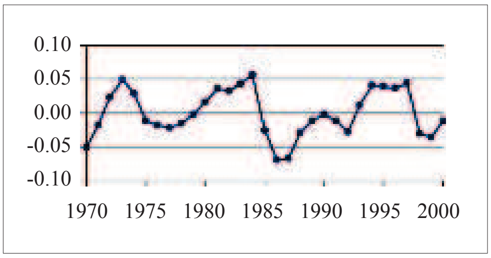
Graph 25
Per capita GDP of
South Korea: effective and trend



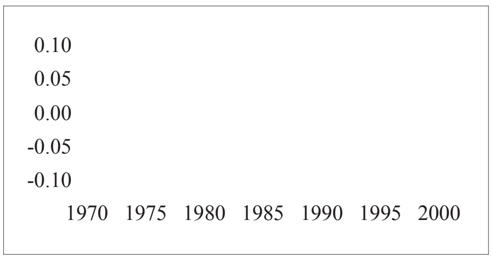
Graph 27
Per capita GDP of
Hong Kong: effective and trend



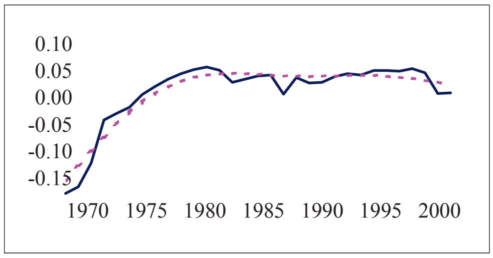
Graph 24
Per capita GDP of
Singapore: cyclical component



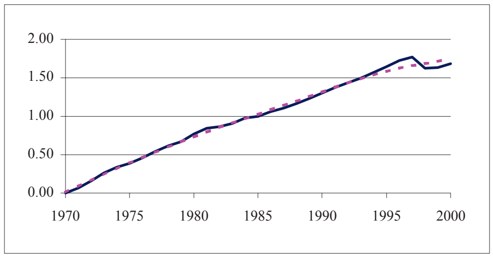
Graph 26
Per capita GDP of
South Korea: cyclical component



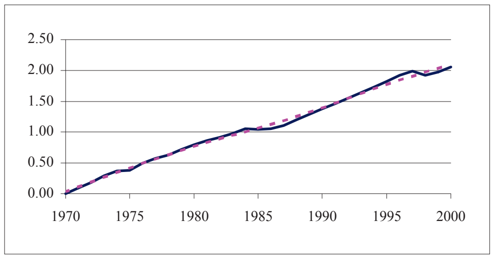
Graph 28
Per capita GDP of
Hong Kong: cyclical component



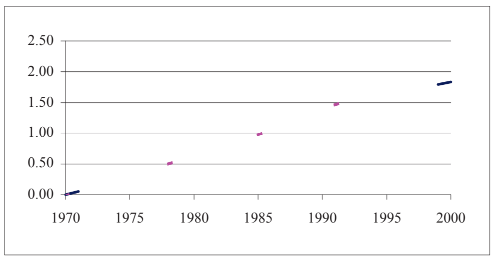
Graph 29
Per capita GDP of
Indonesia: effective and trend



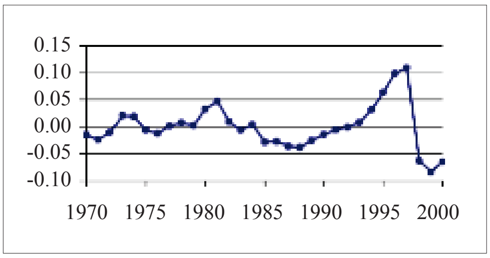
Graph 31
Per capita GDP of
Malaysia: effective and trend



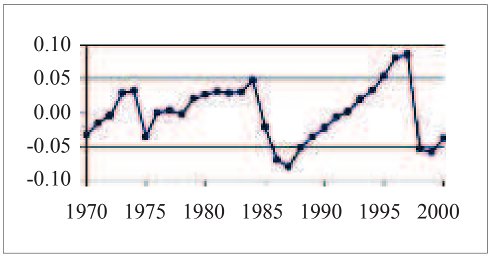
Graph 33
Per capita GDP of
Thailand: effective and trend



Graph 30
Per capita GDP of
Indonésia: cyclical component



Graph 32
Per capita GDP of
Malásia: cyclical component



Graph 34
Per capita GDP of
Thailand: cyclical component