128

DISCUSSION PAPER

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Brasília, January 2015

ACCOUNTING FOR BRAZIL'S GROWTH EXPERIENCE — 1940-2002[1]

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1. We are indebted to Olivier Blanchard and other participants in seminars at NuPE/CdG, Rio de Janeiro, for comments. Remaining errors are entirely our responsibility.

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DISCUSSION PAPER

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SUMMARY

SINOPSE

O trabalho contém uma avaliação quantitativa da experiência brasileira de crescimento no longo prazo, cobrindo o período 1940-2002. A análise mostra que o desempenho da poupança, por si só, não explica a redução das taxas de crescimento depois de 1980. Nossa explicação para esse fenômeno está baseada na evolução da relação produto-capital e nas mudanças dos preços relativos dos bens de investimento. A redução do grau de utilização da capacidade instalada também ajuda a explicar o medíocre desempenho brasileiro desde 1980. Um conjunto de decomposições do crescimento do estoque de capital e do PIB segundo períodos selecionados destaca quais foram os fatores responsáveis pelo crescimento brasileiro nesses períodos.

ABSTRACT

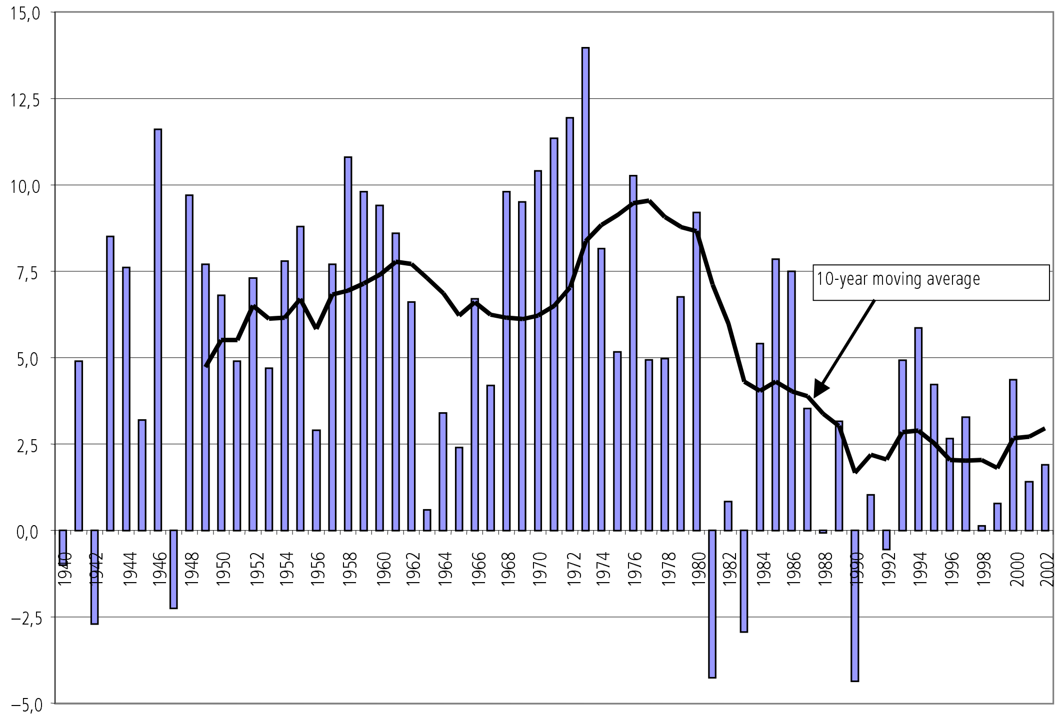
This paper is devoted to a quantitative assessment of Brazil's long-term growth experience. The analysis herein shows that savings alone do not explain the growth slump after 1980. Our explanation centers on the evolution of the output-capital ratio and on changes in the relative price of investment goods. A lower degree of capacity utilization also helps to elucidate Brazil's mediocre growth performance since 1980. Decadal decompositions of capital stock and GDP growth highlight the factors accounting for Brazil's growth in particular sub-periods.

1 INTRODUCTION

A mystery surrounds Brazil's long-term growth experience. Why is it that this country's GDP growth collapsed since 1980 after expanding at some 7% per year from 1940 through 1980? This paper is a first approximation towards a national accounts-based explanation, using a novel way of expressing the equality between savings and investment as an organizing device.

Brazil's growth submersion is summarized in Figure 1, where the yearly GDP growth rates from 1940 through 2002 are exhibited.[1] A ten-year trend line is superimposed to illustrate the downswing of the country's growth rate from 1980, to some 3.0% per year at the beginning of the XXI century.[2]

FIGURE 1
GDP GROWTH RATES—1940-2002
[%]



In Sections 2 and 3, savings, by themselves, are shown not to explain the collapse of Brazil's capital formation and GDP growth. Section 4 demonstrates that, for a fuller description of capital accumulation, account needs to be taken, in addition to savings, of changes in the relative price of investment, the output to capital-in-use ratio, and the degree of capacity utilization.

Sections 5, 6, and 7 dwell on the historical evolution of such variables, and their empirical interrelationships. Section 8 derives a taxonomy of Brazil's growth phases

1. There has been a surge of interest in the analysis of Brazil's growth experience in the last few years [see, for example, Bonelli and Fonseca (1998), Pinheiro et al. (2001), Ellery Jr. et al. (2003), Pinheiro (2003) and Gomes, Pessôa and Veloso (forthcoming)].

2. The Brazilian system of national accounts starts in 1947. Data for previous years are available but with varying quality, especially in what concerns price deflators. For this reason, particularly when dealing with nominal variables, we will center attention on the post-WW II period. A data appendix available from the authors discusses statistical sources, methods, and adjustments.

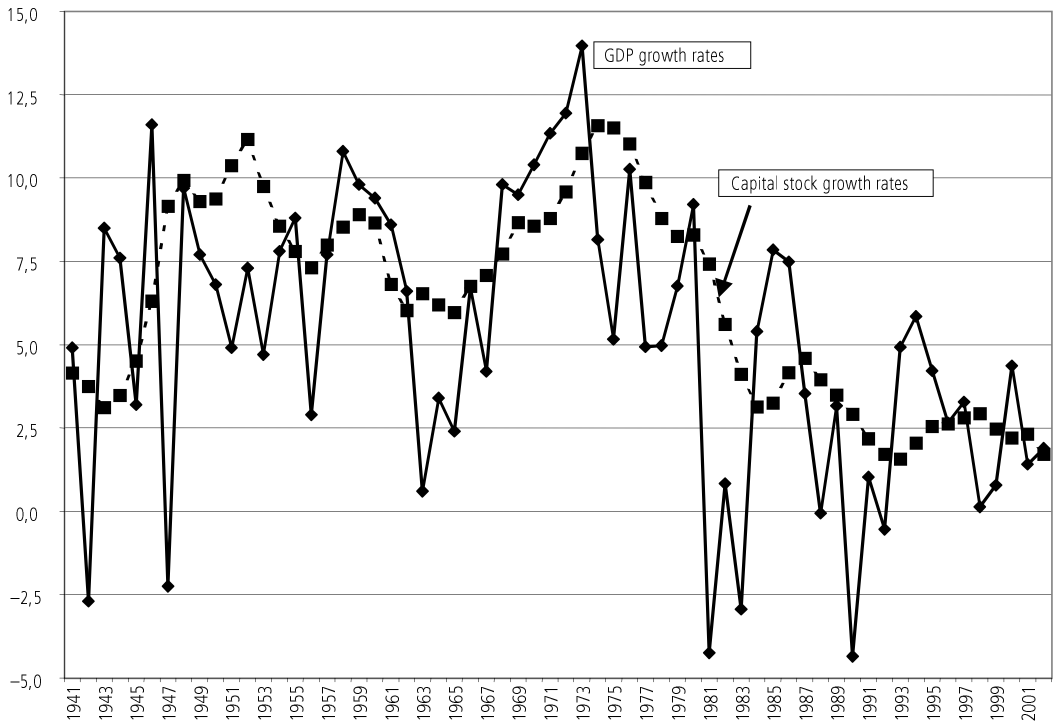
since 1940: alternative decompositions of the GDP growth rates for these phases—according to the AK model and the Solow-Swan model, respectively—indicate the factors accounting for the clogging of the transmission channels to economic progress in the country. Section 9 concludes.

2 GDP GROWTH CORRELATES WITH CAPITAL ACCUMULATION

A natural candidate to start an explanation for the evolution of GDP growth is capital accumulation. In the so-called "Y = AK model", capital accumulation is the only factor responsible for GDP growth. In a Solow-Swan (SS) world, capital accumulation shares responsibility for GDP growth with effective labor, along an adjustment process towards a possibly moving steady state.[3]

This presumption finds comfort in the Brazilian data. Figure 2 graphs the yearly growth rates of the capital stock along with that of GDP.[4]

FIGURE 2
GDP AND CAPITAL STOCK GROWTH RATES—1941-2002
[%]



3. Using the Penn World Table data set, Bernanke and Gurkaynak (2001, esp. p. 20-22) found that the implication of a simple AK model, that country growth rates depend on the saving rate ("proxied" by the real investment rate), was more consistent with the data than the SS model assumption that growth is exogenous. See Section 8 for the specification of the AK model.

4. Lucilene Morandi, from IPEA, graciously provided to us the capital stock series, which was built on the basis of a perpetual inventory method, consistently with the real investment series in Brazil's national accounts. We defined the capital stock for any year t as the geometric average of the Dec. 31 figures for t and $(t-1)$. For details, see Morandi and Reis (forthcoming). Due to the inexistence of appropriate price deflators previously to 1947, the capital stock data is deemed more reliable from the mid-1960s.

A positive association is apparent between the two series. In particular, the GDP growth slump since 1980 is accompanied by a similar collapse of real capital formation. Trend GDP is thus well captured by the evolution of the capital stock, but Figure 2 also indicates that the yearly growth rate of GDP is much more volatile than that of the capital stock. This is as expected in view of the cyclical and irregular components of the GDP series.

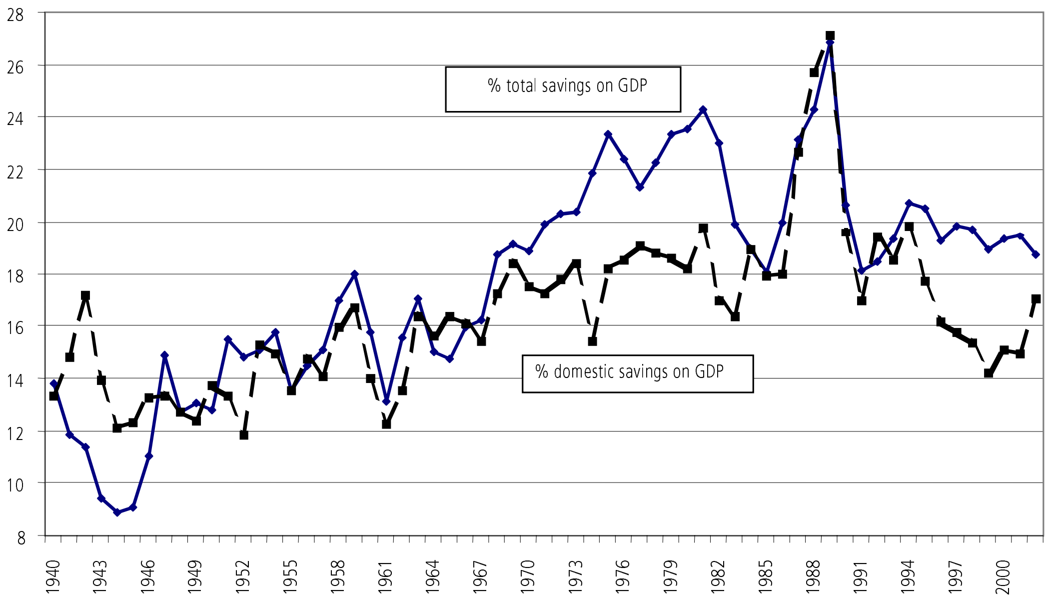
To allow for these fluctuations, we introduce the concept of capital-in-use. This is obtained by multiplying the capital stock by the degree of capacity utilization, calculated as explained in Section 7. The correlation between GDP growth and the growth rate of capital-in-use turns out to be very high ($R = 0.83$).

This confirms that capital accumulation is indeed a good point to start an analysis of the behavior of GDP growth. Keeping in mind that we will later have to deal with other variables, such as the possibly autonomous role of technical progress, we begin our discussion focusing on the determinants of the capital stock growth rate.

3 SAVINGS ALONE DO NOT EXPLAIN THE GROWTH SLUMP

Savings are an obvious candidate to explain the collapse of capital accumulation since 1980. Figure 3 exhibits the behavior of both total (domestic plus foreign) and domestic saving rates (gross savings over nominal GDP), from 1940-2002.[5]

FIGURE 3
SAVING RATES—1940-2002



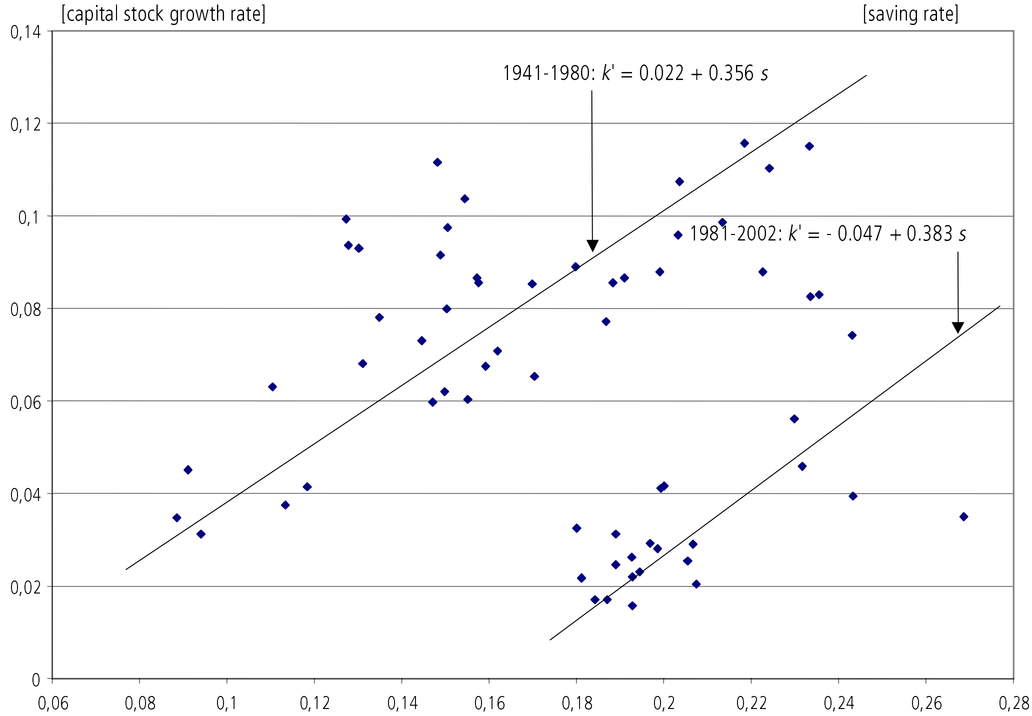
With little fluctuation, the total saving rate averages some 15% of GDP from 1947 through 1965. It escalates to near 24% in 1980, and then sinks to some 19%

5. In Brazil's national accounts, domestic savings are obtained from total savings after deduction of foreign savings, the calculation of which may vary through time. In the following we will privilege an analysis based on total (domestic + foreign) savings and broadly ignore the series for domestic savings. Further to that, due to difficulties of inflation accounting, it is very hard to generate consistent long series splitting domestic savings into private and government savings.

henceforth (with incredible volatility during the 1980s hyperinflation). The movements in this period are sharp, but bear little relation to the slump of capital formation after 1980.

This lack of association is documented by a non-significant correlation coefficient of $R = -0.02$ between capital stock growth and the total saving rate for the 1941-2002 period. The scatter diagram between the two variables in Figure 4 is indicative of their weak—and negative, for that matter—association for the period as a whole.

FIGURE 4
SCATTER DIAGRAM BETWEEN CAPITAL STOCK GROWTH AND TOTAL SAVING RATE—1941-2002



On closer inspection of the data, and as indicated in Figure 4, a structural break seems to have occurred from the early 1980s on the relationship between the saving rate and the capital stock growth rate. This is confirmed by the following simple linear regression, with a dummy variable added, equal to 0 in 1941-1980 and to 1 in 1981-2002.

The results in Table 1 suggest the possibility of a stable relationship between K' and s for the period as a whole, in the sense that one additional percentage point in the saving rate raises the capital stock growth rate by 0.36 percentage points. However, a major mysterious downward shift occurs in the yearly growth rate of the capital stock since 1981: independently of the saving rate it becomes 6.4 percentage points lower than it used to be until 1980.

This result also indicates that the apparent lack of relation between capital accumulation and the saving rate for the period as a whole does not mean that the saving rate does not matter for capital accumulation; only that savings by themselves cannot explain Brazil's growth plunge since the 1980s. The following sections investigate which variables might be clogging the transmission mechanism from savings to capital accumulation and GDP growth in Brazil.

TABLE 1
REGRESSION BETWEEN *K'* AND *s*, WITH A STRUCTURAL BREAK

	Dependent variable: K' (capital stock growth rate)					
Adjusted R^2	0.7597					
Standard error	0.0149					
Number of observations	62	(1941-2002)				
	Coefficients	Standard error	Stat t	P-value	95% inferior	95% superior
Constant	0.0215	0.0091	2.36	0.0214	0.0033	0.0398
Saving rate	0.3596	0.0540	6.66	0.0000	0.2517	0.4676
Dummy 1981-2002	–0.0637	0.0046	–13.95	0.0000	–0.0728	–0.0545

4 FULLY ACCOUNTING FOR CAPITAL ACCUMULATION

Is the failure of savings by themselves to explain the post-1980 Brazil's capital (and therefore GDP) growth plunge a second mystery in this country's growth experience? Not really. In fact, besides the saving rate, s (defined as the ratio of total nominal savings, S, over nominal GDP, P_yY), the determinants of capital accumulation include the degree of capacity utilization, $\boldsymbol{u}$; the relative price of investment, $\boldsymbol{p}$ (defined as the ratio of the implicit price deflator of fixed investment, P_i, to the implicit price deflator of GDP, P_y); and the output to capital-in-use ratio, $\boldsymbol{v}$ (defined as real GDP, Y, over capital-in-use, $\boldsymbol{u}.K$).

To confirm this, start from the capital accumulation equation:

$$K' = I/K - \delta \qquad (1)$$

where K' is the capital stock growth rate; I, gross real investment; K, the capital stock; and δ the depreciation rate.

The ratio of gross real investment to capital stock (I/K) can be written as the gross real investment rate (real investment, I, divided by real GDP, Y) times the output to capital ratio:

$$I/K = (I/Y).(Y/K) \qquad (2)$$

The gross real investment rate (I/Y), in turn, is identically equal to the product of the (nominal) saving rate by the inverse of the relative price of investment:

$$I/Y = (P_iI/P_yY).(P_y/P_i) = (S/P_yY).(P_y/P_i) = s.(1/\boldsymbol{p}) \qquad (3)$$

where the first equality is just an artifact to introduce the nominal investment rate (P_iI/P_yY), and thus make use of the equality between nominal savings and nominal investment in the second equality.[6] The third equality is merely a consequence of the definitions of $s = S/P_y Y$ and $p = P_i / P_y$.

The output to capital ratio (Y/K) can be written as the product of the capacity utilization rate, u, by the ratio of output to capital-in-use, v:

$$Y/K = u.(Y/uK) = u.v \tag{4}$$

Substituting (3) and (4) in (2) and the result in (1), we finally obtain:

$$K' = s.(1/p).u.v - \delta \tag{5}$$

Equation (5) clearly shows that the impact of the saving rate (s) on the capital stock growth rate (K') is conditioned on the relative price of investment (p), the capacity utilization rate (u), and the output to capital-in-use ratio (v). The depreciation rate (δ) needs also to be taken into account—except for the fact that, as it is nearly a constant, varying between 0.038 and 0.040 in the series we use, it does not contribute to explain changes in capital accumulation through time.

Table 2 shows the correlations between the series for GDP growth Y' and those for K', v, u, p, and s in 1941-2002 and 1952-2002 (this second period is selected because, as we will see in the following, 1952 is a critical turning point in Brazil's growth experience).

TABLE 2
CORRELATION MATRICES

A: 1941-2002	*Y'*	*K'*	*U*	*v*	*p*	*s*
Y'	1.000					
K'	0.515	1.000				
U	0.700	0.718	1.000			
V	0.368	0.504	0.514	1.000		
P	–0.533	–0.854	–0.650	–0.679	1.000	
S	–0.166	–0.020	–0.199	–0.778	0.425	1.000
B: 1952-2002	*Y'*	*K'*	*U*	*v*	*p*	*s*
Y'	1.000					
K'	0.604	1.000				
U	0.739	0.714	1.000			
V	0.593	0.837	0.684	1.000		
P	–0.590	–0.861	–0.605	–0.922	1.000	
S	–0.199	–0.084	–0.188	–0.541	0.509	1.000

6. Only recently, inventory changes began to be calculated in Brazil's national accounts. For most of the series, such inventory changes are incorporated to private consumption. For this reason, for the whole series we defined gross savings to be equal to nominal gross fixed investment. In Brazil's national accounts, savings continue to be estimated as a residual, hence the equality between savings and investment holds without any statistical discrepancy.

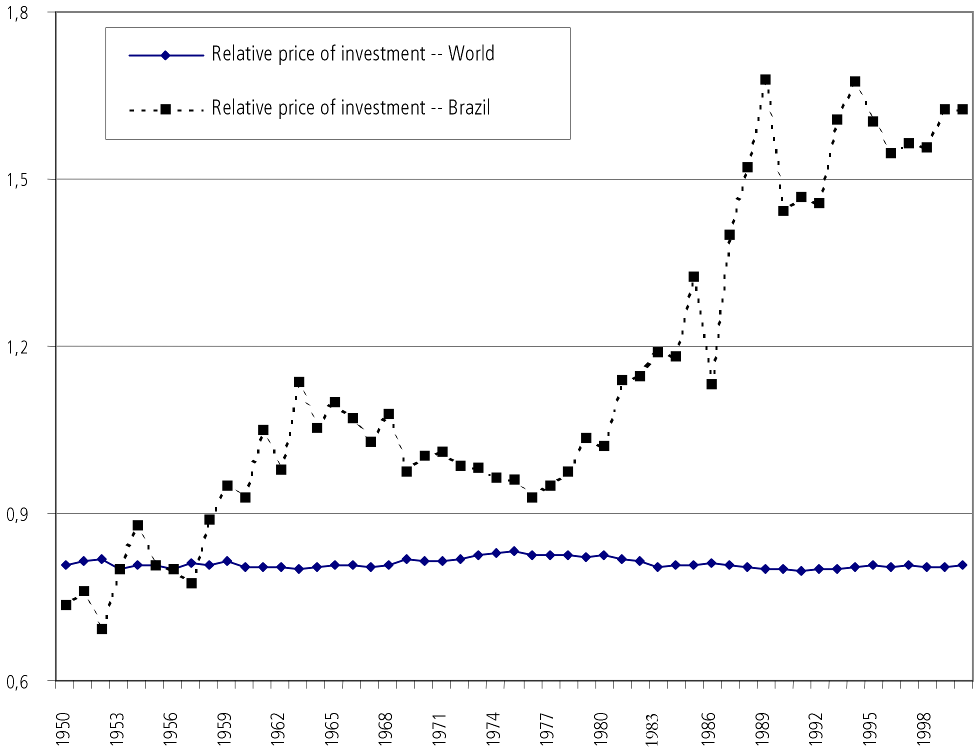
The correlation coefficients between Y' and K' are 0.52 (1941-2002) and 0.60 (1952-2002). In both periods, the degree of capacity utilization, u, is the variable with the closest association with the yearly GDP growth rate (R = 0.70 and 0.74, respectively in 1941-2002 and 1952-2002). Next in line are the relative price of investment goods, p (R = –0.53 and –0.59, respectively), and the output to capital-in-use ratio, v (R = 0.37 and 0.59, respectively). As previously noted, the saving rate s is negatively correlated (albeit not significantly in some cases) with all growth-related variables.

Interestingly enough, p and v are among the variables with the closest interrelationship in the statistical series (R = –0.68 in 1941-2002 and a whopping –0.92 in 1952-2002), followed by those between K' and p. The next sections try to decipher the implications of such associations for the historical behavior of the capital stock growth rate.

5 SUSTAINED INCREASE IN THE RELATIVE PRICE OF INVESTMENT

Figure 5 displays the extraordinary behavior in 1950-2000 of the relative price of investment, defined as the ratio between the price deflator of gross fixed investment and the price deflator of GDP.[7] The same figure displays the evolution in 1950-2000 of a similar variable: the world average for the relative price of investment at international dollar prices, from the Penn World Table (PWT)—6.1 version.

FIGURE 5
RELATIVE PRICE OF INVESTMENT: BRAZIL AND WORLD—1950-2000



7. These figures are from the PWT project and are not exactly the same as those directly derived from the Brazilian National Accounts. However, the correlation coefficient between the two relative price series is very high: R = 0.962. In the PWT, the numeraire for all price indices in all years is the US GDP deflator. For the PWT data, see Heston, Summers and Aten (2002).

In broad outline, the relative price of investment in Brazil increases rapidly between the early fifties and the mid-sixties. It then drops a little through the mid-1970s. Subsequently, it rises very sharply. In the early 1990s, *p* is more than twice as high as in the early 1950s.[8] Such an increase in the relative price of investment is a Brazilian anomaly in a worldwide perspective. The PWT world average for this price ratio remains nearly constant in the 1950-2000 period, as shown in Figure 5.

Possible explanations for the rise of the relative price of investment in Brazil include:

a) increased oligopoly power in industries producing both final and intermediate investment goods (such as cement);

b) inefficiencies in the capital goods production process, as more and more of previously imported goods are produced domestically;

c) higher demand for durable goods, particularly low-cost housing—as a refuge against hyperinflation and a defense against financial default risks—, with reflexes on the relative price of such goods along an upward sloping supply curve;[9]

d) oligopolistic price-makers' defensive pricing behavior in face of government's procurement payment delays, in a context of accelerating inflation;[10] and

e) the latter may have been associated, as proposed in Pinheiro (2003), to a price index measurement error, i.e., an overestimation of the increases of the nominal prices of investment goods, during the 1987-1989 hyperinflationary period, by the FGV wholesale price and national construction cost indexes, traditionally used to estimate nominal fixed capital formation.

Factors (*a*) and (*b*) may have operated more forcefully through the early 1980s. Factors (*c*) to (*e*) may have become important when inflation got out of control from the early 1980s. However, the relative price of investment goods does not yield to price stabilization after 1994, which suggests that it is either measurement error or relative cost (cum market power), and not speculative demand, that explains the post-1980 behavior of this variable. Furthermore, speculative (or precautionary) demand for durable goods should impinge on the prices of capital goods in place, not necessarily on the cost of new investment goods, which are the object of our analysis.

Consideration of the behavior of the output to capital-in-use ratio will help to further our understanding of the evolution of *p*.

8. In the Brazilian National Accounts the relative price of machinery and equipment replicates the pattern for the relative price of investment, except for wider fluctuations probably associated to changes in the pricing of imported machinery in some periods, due to real exchange rate movements and trade policy changes—e.g., during the trade liberalization in the early 1990s. For an early analysis of the behavior of the relative price of investment goods in Brazil, see Carneiro and Werneck (1993).

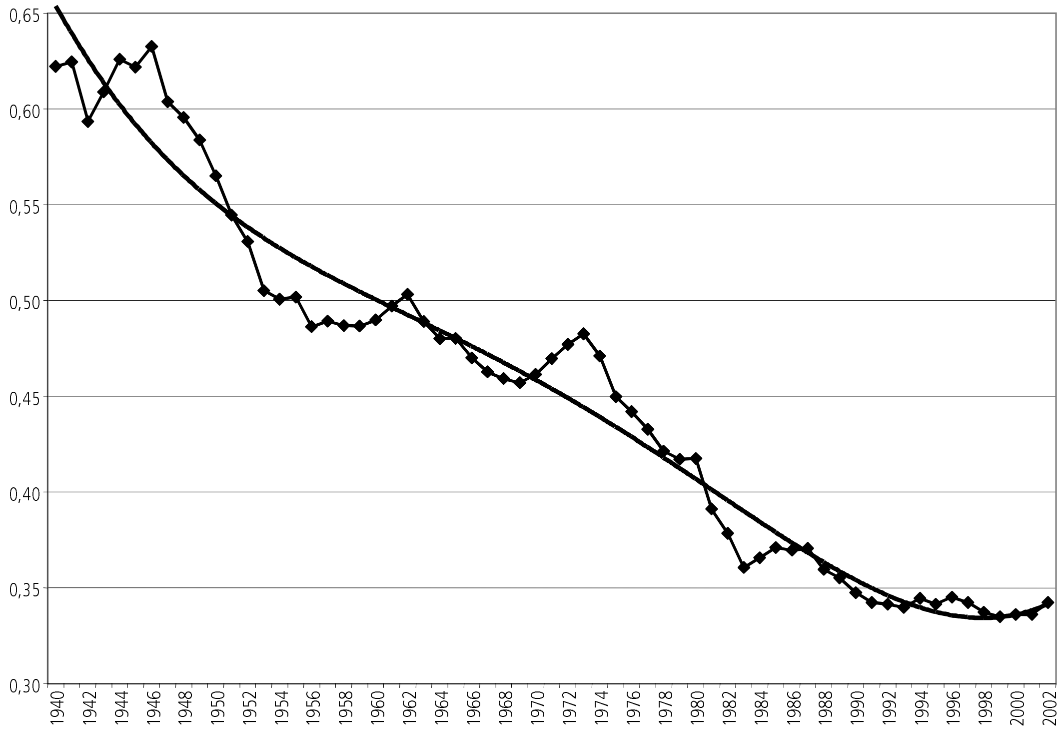
9. For this hypothesis, see Bugarin et al. (2003).

10. The price deflators for investment goods in the Brazilian National Accounts apparently continue to be derived from the wholesale price and national construction cost indexes provided by Getulio Vargas Foundation (FGV). That is, volume indexes for fixed investment, from a production-side perspective, are calculated; then the price indexes for the different products are inserted, to generate a nominal (volume x price) GDP series. Sector-wide price deflators are then calculated, as the ratios between the nominal and the real values of the different components, from a demand-side perspective. The FGV wholesale price indices are often derived from "listed" prices, obtained from a sample of firms. For durable goods, which are normally sold on credit, such "listed" prices may have incorporated a premium, increasing with both inflation and the payment delays in government procurement.

6 FALLING OUTPUT TO CAPITAL-IN-USE RATIO

Figure 6 displays the behavior of the output to capital-in-use ratio, v, in the 1940-2002 period. In the figure, along with the constructed series for v, a polynomial approximation is drawn to facilitate the visualization of the trend. The ratio v was obtained by dividing real GDP (i.e., at constant 2000 prices), Y, into the real capital stock in use, $u.K$.[11]

FIGURE 6
OUTPUT TO CAPITAL-IN-USE RATIO (v)—1940-2002



The striking fact in Figure 6 is the long-term declining trend of v, from the immediate post-WW II to the early 1990s. In more detail, starting from a high level of a little over 0.6 (1 unity of yearly output per 1.67 units of capital) in the early 1940s, the output to capital-in-use ratio increases during WW II and then declines continuously through the mid-fifties to near 0.5. From the mid-1950s to the mid-1970s v fluctuates along a mild negative trend. The next stage is a sharp contraction of v, starting in 1973 and only pausing in 1983, with v reducing to some 0.36. A minor decrease follows after 1987, until v stabilizes at some 0.34 from the early 1990s (average 1992-2002).

Such epochs are broadly consistent with Brazil's industrialization experience: light import substitution during the war through the mid- 1950s, consumer durables import substitution in the late 1950s and 1960s, heavy import substitution of capital goods and intermediate products from the early 1970s through the early 1980s.

11. The capital stock series is from Morandi and Reis (forthcoming); the series for u is derived in the next section.

BOX 1
CRITICAL POLICY CHOICES IN THE 1950s

The years 1952 through 1955 where critical to define the industrialization pattern that Brazil followed henceforth. In 1952, President Vargas (1/1951-8/1954), under the prodding of finance minister Lafer (2/1951-6/1953), reinstated the pre-war coffee valorization policy, as a means of defending a real exchange rate that became artificially overvalued when the Korean War boom ended. This was followed by finance minister Aranha's (6/1953-8/1954) institution of a multiple exchange rate system in 1953, as a means of privileging "essential"' imports (defined as those not produced domestically). In parallel, the National Development Bank (BNDE) was created in 1952 and Petrobras in 1953.

Under conservative President Café Filho (8/1954-11/1955), who took over after Vargas's suicide in August 1954, finance minister Gudin (8/1954-4/1955) attempted to revert the coffee valorization scheme but was forced to resign. His successor, Mr. Whitaker (4/1955-10/1955), tried to dismantle Aranha's multiple exchange rate system, only to be fired as well. President Café Filho himself was overthrown in the so-called "democratic anti-coup" of November 1955. With the election of President Juscelino Kubitschek (1956-1960), the game was over and Brazil embarked on a path of import substitution that was to last until the 1980s.

Commenting on the downfall of finance minister Whitaker, one of us wrote in 1992:

"History can never be rewritten, but one wonders on how different post-Korean War Brazil's economic history would have been, if Whitaker's proposals had been approved. For the rejection of his proposed exchange [rate system] reform meant the defeat of an export-led vision of growth, and, in some measure, the option, which would become more explicit in president Kubitschek's (1956-60) term, to deepen the import substitution industrialization process" [Bacha (1992, p. 74)].

Three alternative hypothesis present themselves to explain the decline of v:

a) first, a decline in the output-capital ratio may be expected, as an economy moves from a predominantly rural stage (which was Brazil until the 1930s) to escalate into a full industrial economy. This tendency may have been accentuated by specific characteristics of Brazil's industrialization: a heavily protected low-scale import substitution process, accompanied by an oligopolistic pattern of industrialization under the dominance of government-owned firms;

b) second, Brazil's experience may be simply reflecting a more general worldwide trend of declining output to capital ratios; and

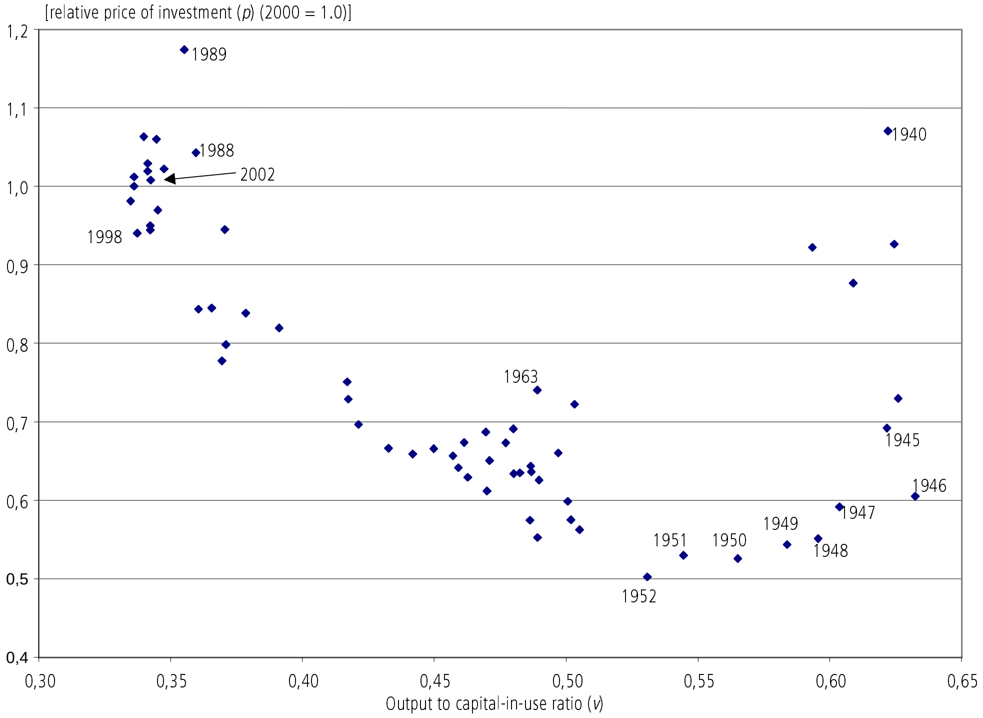
c) finally, in a Solow-Swan world, the output to capital ratio is not a technological datum, and may decline because it is converging towards a lower steady-state value, consistent with, for example, a lasting increase in the saving rate.

We consider each of these hypotheses in turn.

6.1 GUILTY BY ASSOCIATION: RELATIVE PRICES INCREASE AS PRODUCTIVITY FALLS

Figure 7 reinforces the suspicion that the nature of the import substitution path chosen by Brazil from the early 1950s may be behind the observed behavior of the series. This is a scatter diagram, with the output to capital-in-use ratio in the horizontal axis and the relative price of investment goods in the vertical axis.

FIGURE 7
NEGATIVE CORRELATION BETWEEN *v* AND *p* SINCE 1952



From the early 1950s, accompanying the decisions spelled out in Box 1 to deepen the import substitution process, the relative price of investment goods and the output to capital-in-use ratio display a negative correlation, particularly strong after 1973 (Figure 7): as one increases, the other falls, all the way through the early 1990s.

Brazil is the "worst offender" in a PWT 6.1 listing of 63 countries with data for 1960-2000, in terms of the combination of relative price of investment increase (p') and positive correlation (R) between the relative price of investment and the capital-output ratio. For Brazil, this pair is (p' = 168.7% and R = .90). Runner-ups are Venezuela (p' = 118.5% and R = .87), Israel (p' = 111.9% and R = .80), Iran (p' = 84.0% and R = .51), Greece (p' = 70.4% and R = .95), and Singapore (p' = 69.2% and R = .94).

To help fix ideas about a possible causation sequence, think of a one-sector open economy, initially producing consumption goods for both domestic use and exports, while importing capital goods to expand capacity. Introduce in this economy a (relatively inefficient) capital goods producing sector towards which, at the margin, consumption goods that could be exported are increasingly diverted, in exchange for domestically produced investment goods. As the size of the diversion increases, overall productivity declines, but this can be temporarily masked if the introduction of the capital goods producing sector is accompanied by an extra-saving effort.

BOX 2
THE GENERALS' *FUITE EN AVANT*

A critical decision defining Brazil's economic future and industrialization pattern followed on the first oil shock of 1973. General Geisel's Government (1974-1979) took the decision to fight such adversity doubling the bet on extra-heavy import substitution. This decision could be put into effect only through a deep reliance on the international recycling of the petrodollars. With the benefit of hindsight, this was an unfortunate course of action, as the international scene deteriorated continuously from the late 1970s onward.

Moreover, in the domestic economy, increased wage indexation accompanied the political opening up of the military regime that was promoted by the same general Geisel and carried out by general Figueiredo (1979-1985). Excess domestic demand and wage indexation led the external debt and domestic inflation to increase substantially. The financial crises of the early 1980s put an end both to the military regime and to Brazil's growth miracle. Brazil's return to democracy occurred in 1985 under a heavy debt burden and accelerating inflation. There followed a period through 1993 of hyperinflation and disparate economic policy-making, under the aegis of successive failed "heterodox" stabilization attempts.

This indeed seems to have happened in Brazil. As displayed in Figure 3, the total saving rate increased to 20% of GDP in the early 1970s (from some 15% in the 1950s) with a big help from foreign savings. Together with an increase in capacity utilization, this was more than sufficient to produce the "Brazilian economic miracle" of the earlier part of the military regime (1965 through 1974). In the latter part of the regime, from 1974 through 1984, following on the generals' decision (described in Box 2) to deepen industrialization under very adverse international conditions, the output to capital-in-use ratio declined 24%, while, in a highly symmetric movement, the relative price of investment goods increased 33%.

6.2 INTERNATIONAL CAUSATION: A WORLDWIDE TENDENCY TOWARDS INCREASED CAPITAL INTENSITY

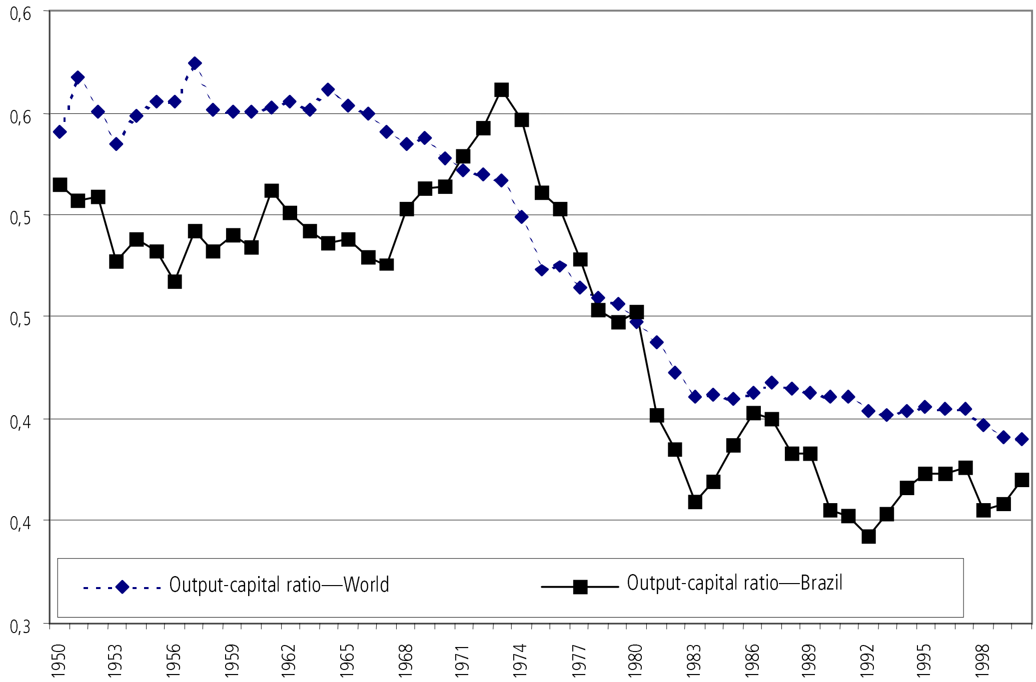
Figure 8 compares the evolution of the output-capital ratio in Brazil with an unweighted average output-to-capital ratio of a sample of 83 countries, for the 1950-2000 period.[12] Brazil's pattern broadly coincides with the world average, which also declined in the post-1970 period, possibly as a reaction to the oil shocks. Brazil's ratio are always lower than the world average, except in the 1967-1973 period. These results are only suggestive, because the PWT-based capital stock data can only be relied on after 1970.[13]

12. Samuel Pessôa gently made available to us his series for the output-to-capital ratio for the 83 countries, based on PWT data. Since these series are not adjusted for the degree of capacity utilization, we also used Pessôa's series, based on the PWT data, for the Brazilian case. Thus, strictly speaking, the series shown in Figure 9 are, in the terminology of this paper, not for v itself, but rather for $v.u$. In addition, Pessôa's data for 1950-1959 comprises only 47 countries. We used the ratio between the average output-capital ratio of this sample to that of the complete sample in 1960 to correct the 1950-1959 data and thus prevent the series from jumping when the complete sample was introduced in 1960.

13. This is because Gomes et al. (2003) used a simulated capital stock value for 1950 (or 1960, depending on the country) to generate a capital stock series from the PWT, and then completed the series applying a perpetual inventory method to the constant-price investment data from then onwards.

FIGURE 8

BRAZIL AND WORLD: OUTPUT-CAPITAL RATIOS—1950-2000 (PWT)



6.3 ADJUSTMENT TOWARDS A SOLOW-SWAN STEADY STATE

One well-known result of the Solow-Swan model, is that if the output to capital ratio is not constant, it is converging to its steady-state value. To obtain such value observe that the steady state capital growth rate (as well as that of GDP, Y'_{ss}) is given by:

$$K'_{ss} = A' + N' \tag{6}$$

Where A' is the growth rate of total factor productivity and N' is the growth rate of the labor force (working age population). Figure 9 shows our estimated series for N' and for its sum with A'.[14]

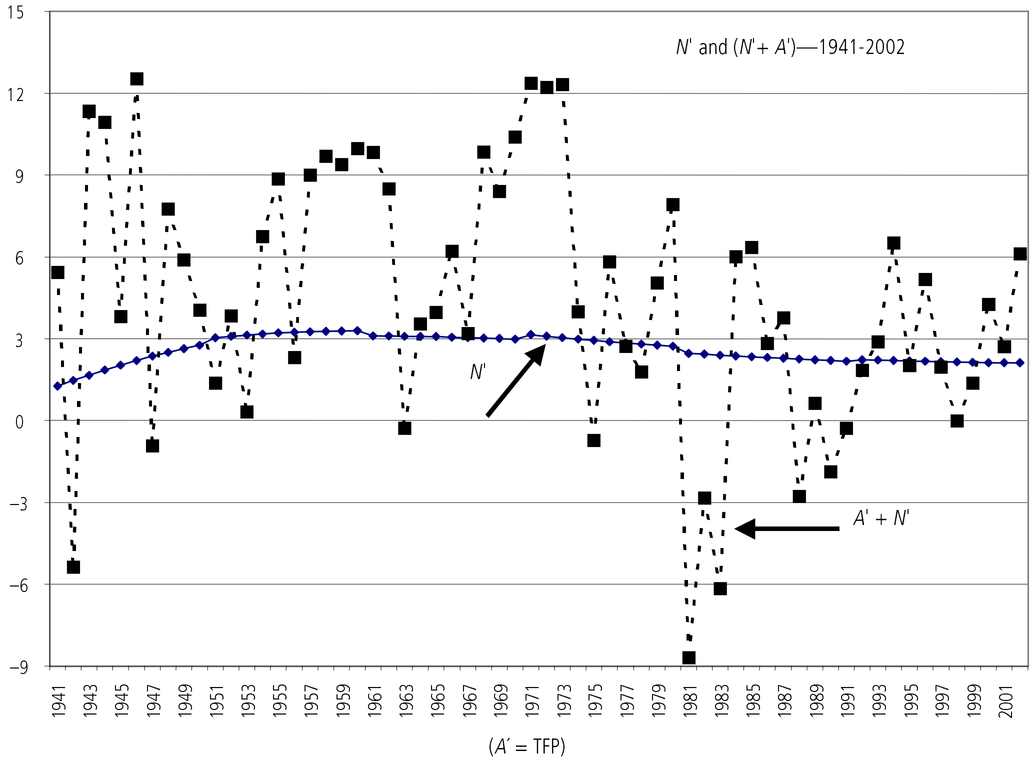
The behavior of A', which is estimated as a residual, turns out to be highly congruent with the volatile pattern of observed GDP growth (the latter can be seen in Figures 1 or 2). Because of this year-to-year volatility, we will work with annual averages for representative periods in the following section, when discussing Brazilian characteristic growth epochs.

Broadly speaking, two long waves are suggested from the figure: one previous to the mid-1970s—when A' was generally very high—and another after the mid-1970s—when A' was generally very low. More recently, i.e., from 1988 on, A' seems to be trending upward. The suggestion in Figure 9 is that, from the perspective of

14. A' was estimated as the residual in a Cobb-Douglas production function with labor-augmenting technological progress, assuming a value of 0.5 for the elasticity of output with respect to capital in use. The data for employment and working-age population were extracted from the decadal population Census (see Table 8) and interpolated for the remaining years, assuming a constant elasticity (within each decade) with respect to the growth of the capital stock in use.

total factor productivity, the slump in Brazil's growth started not in the 1980s but in the 1970s. We will elaborate on this hypothesis in the next section.

FIGURE 9
WORKING FORCE GROWTH (*N'*) AND STEADY STATES VALUES OF $Y'_{ss} = K'_{ss} = A' + N'$
[%]



The steady-state value v_{ss} is now easy to calculate. One needs simply to replace the steady-state value of K', given in (6), in the expression for capital accumulation (5), to obtain:

$$v_{ss} = (\delta + A' + N')/s.(1/p).u \tag{7}$$

Putting together the estimates for $s(1/p)u$ and $A'+ N'$ (plus δ), we calculate the values of v_{ss} that are shown in Figure 10, together with the observed value of v.

Contrary to conventional textbook wisdom, v_{ss} is not a constant but fluctuates widely. However, the calculated v_{ss} are lower than observed v for most of the period. Hence, a long-term adjustment process towards a lower steady state value might also explain the downward trend of v. This presumption from the Solow-Swan model is confirmed by the regression results in Table 3.

The coefficients of $v(-1)$ and v_{ss} add up to one, as expected from a process of adjustment in which v converges asymptotically to v_{ss}. In addition, and very importantly, the coefficient of v_{ss} indicates that only 6% of the distance between v and v_{ss} is covered in a single year. This means that it takes nearly 12 years to close one half of the gap between observed v and its corresponding steady state value.[15]

15. This result is similar to the numerical simulations of the speed of convergence of a linearized numerical Solow model, in Romer (2001, p. 24-25). In his simulations, Romer estimates that only 4% of the distance between the observed and the steady state value of the capital to effective labor ratio is covered in a single year.

FIGURE 10
STEADY STATE AND OBSERVED VALUES OF THE OUTPUT TO CAPITAL-IN-USE RATIO (*v*)—1947-2002

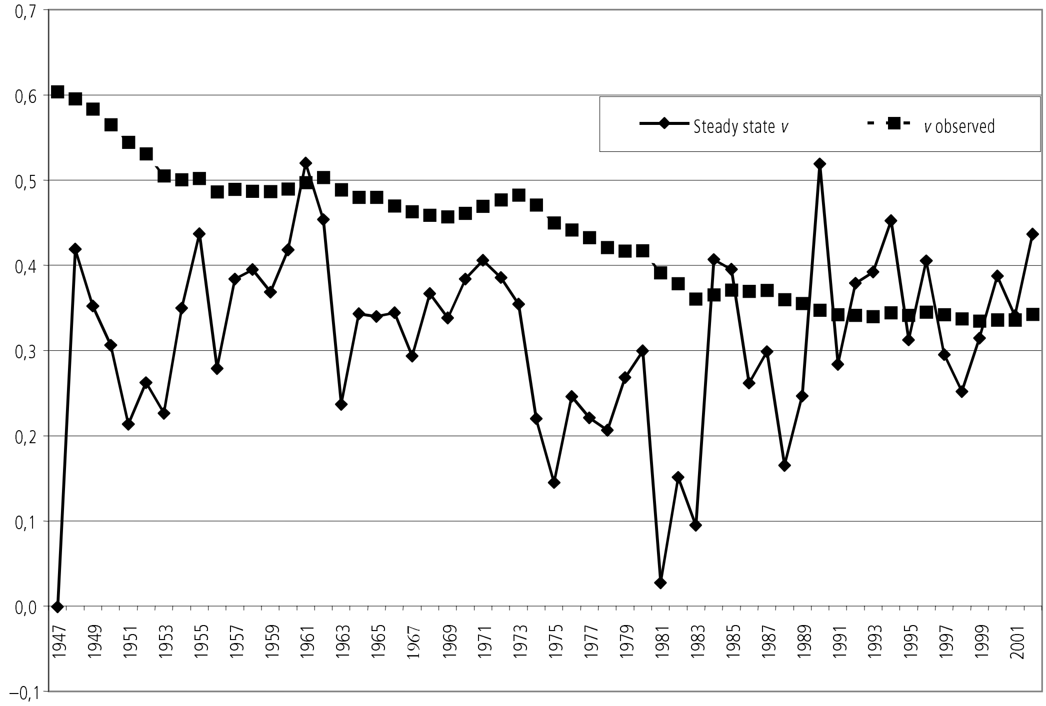


TABLE 3
REGRESSION RESULTS—DEPENDENT VARIABLE: *v*

Adjusted R^2	0.977					
Standard error	0.005					
Number of observations	55	(1948-2002)				
	Coefficients	Standard error	Stat t	P-value	95% inferior	95% superior
$v(-1)$	0.9458	0.0045	208.6	0.0000	0.9367	0.9549
$v(ss)$	0.0597	0.0060	9.95	0.0000	0.0477	0.0717

7 HYSTERESIS OF IDLE CAPACITY?

The last and statistically most controversial component of our explanation for the demise of Brazil's growth is the fall in the degree of capacity utilization, u. The construction of a series for this variable is not an easy statistical endeavor.

Since 1968 there is an objective measure to grasp the level of u: it is the degree of industrial capacity utilization reported in the quarterly surveys conducted by the FGV. But there are two problems associated with it. The first is how to generalize the value of u in industry to the rest of the economy. We simply assumed that 65% of GDP was cyclically variable in tandem with industry, and the remaining 35% was always under full capacity: 65% would be our very rough estimate for the average share of non-farm business output in Brazil.[16] Thus, we defined the overall degree of

16. Shares of (Agriculture + Government + Rents)/GDP at factor cost observed in: 1950 = 44%; 1960 = 35%; 1970 = 32%; 1980 = 25%; 1985 = 28%.

capacity utilization as: $u = 0.65.(u_{ind}) + 0.35.(1.0)$, where u_{ind} is the degree of capacity utilization from the FGV surveys (annual averages).

The second problem is identifying a level of utilization that could be called "full". Fortunately, in 1973 capacity utilization in industry reached 90% on a more or less sustained basis, and this is the maximum level in the whole series. Hence, we defined the overall level of capacity utilization in 1973 as full, that is we made $u = 1.0$ for 1973, and multiplied the levels of capacity utilization in the remaining years by 1.11.

Our procedure to grasp the value of u in the 1940-1968 period was more tentative: it involved the estimation of a value for u_{ind} from an auto-regressive relation in which this variable was made a function of the growth rate of manufacturing output and lagged u_{ind}.[17] for the 1969-2003 period. The regression results were the following.

Next we chose 1936 as the year from which to start simulating values of u_{ind} from 1940 to 1968, using the above regression. Trial and error led us to arbitrate the value of $u_{ind} = 0.87$ in 1936.[18] With such simulated values of u_{ind}, we obtained values for the economy-wide degree of capacity utilization using the same procedure adopted for the 1968-2002 period.

TABLE 4
REGRESSION RESULTS—DEPENDENT VARIABLE: u_{IND}

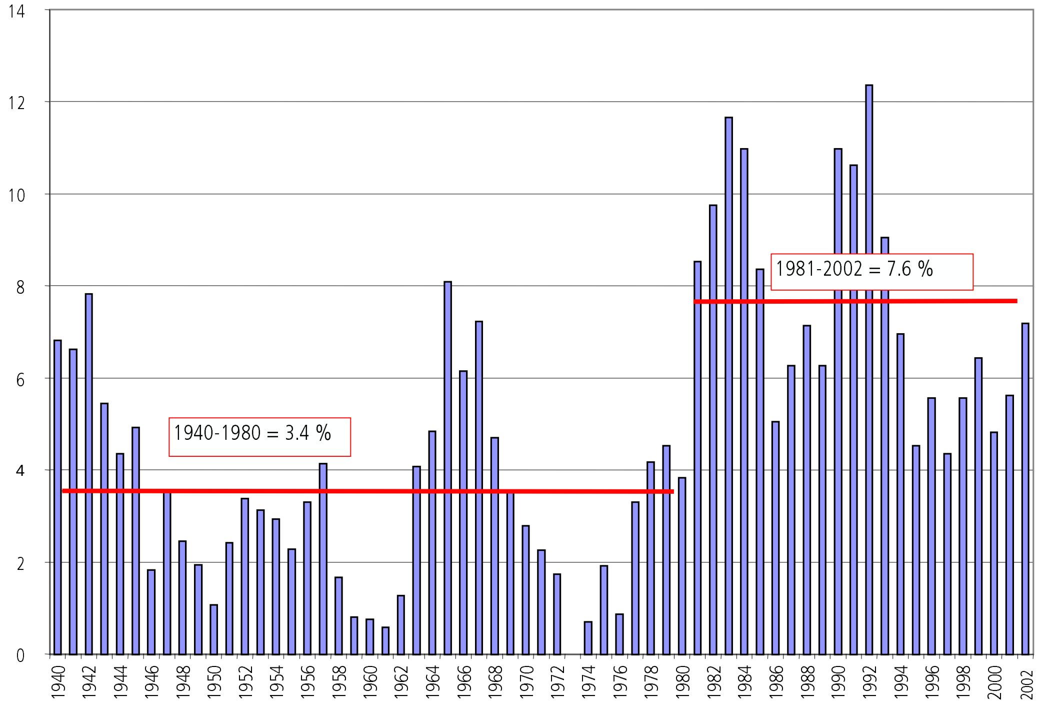
Adjusted R^2	0,9417					
Standard error	0,0113					
Number of observations	35	(1969-2003)				
	Coefficients	Standard error	Stat t	P-value	95% inferior	95% superior
Intercept	0.1530	0.04032	3.79	0.0007	0.07043	0.23488
Manufacturing output growth rate	0.0039	0.00032	12.18	0.0000	0.00326	0.00457
$u_{ind}(-1)$	0.7815	0.04807	16.26	0.0000	0.68342	0.87950
Dummy 1985-2003	0.0176	0.00463	3.79	0.0006	0.00813	0.02703

Figure 11 shows the behavior of the estimated degree of economy-wide idle capacity, $1 - u$, from 1940 through 2002. "Normal" cyclical patterns are depicted through the late 1970s. But, from the early 1980s on, Brazil's economy seems unable, even temporarily, to return to a state of full capacity utilization.

17. Simple inspection of the scatter diagram between the series suggests the existence of a structural break after 1985: for the same manufacturing growth rates the degree of utilized manufacturing capacity is slightly higher after 1985. Accordingly, a linear dummy was added to the model from 1985 on.

18. This is a very high value in the series, corresponding to the level achieved in the mid-1970s (more specifically, it is equal to the value observed in 1976). The justification for such a high estimate are the very high growth rates of manufacturing output in 1936 and in the immediately preceding years: 11.7% (1933), 11.1% (1934), 11.9% (1935) and 17.2% (1936). These rates are similar to those observed during the Brazilian "miracle" in the early 1970s [see IBGE (1990)]. It is comforting to find out that the adoption of this procedure results in an estimate of 0.844 for the value of u in 1969, very close to the observed value of 0.847.

FIGURE 11
IDLE CAPACITY—1940-2002
[%]



A permanent lack of effective demand may hardly be argued to be the reason for such state of affairs, since, in a number of years in this period (e.g., 1986, 1989, 1995-1996), inflation or external deficits clearly accelerated under the pressure of excess domestic demand.

Over the 40 years previous to 1980 the average degree of idle capacity was 3.4%. After 1980, this average increased to 7.6%. By the same token, previously to 1980, the minimum degree of idle capacity was 0, whereas, after 1980, this minimum level was roughly 4.4%. Without further study, it is not clear if we should pick the average or the minimum as an estimate of a "normal" rate. But both would suggest an increase of a little over 4.0 percentage points in idle capacity from pre-1980 to post-1980. Why would this have happened?

One hypothesis is that we may be understating the degree of idle capacity previously to 1973, because our estimating procedure for this period is very indirect, resulting from an inference about the rate of change of industrial production, and not from direct observation. All we can say in defense of our procedure is that this was the best that we could do, after much reflection and experimentation, and that we do not identify any specific bias in the procedure we adopted.

Independently of agreement with our estimation method for 1940-1968, it is still true that the levels of industrial capacity utilization observed in the FGV survey in the early to mid-1970s were never reached again after 1980. Actually, it was only at the height of the demand boom provoked by the Real stabilization Plan (1995 and 1997) that the relatively low degree of industrial capacity utilization of 1968 was reached again in the post-1980 period.

To understand the reasons behind this negative performance is more than we can do here. Merely in terms of research topic suggestions, first in our list would be the successive defaults on domestic and external public debt in the 1980s, summarized in Box 3. A hypothesis is that these defaults raised the required rate of return on capital, thus tending to accelerate the rate of inflation. This implied the need for a higher "natural" rate of unemployment ("proxied" by a lower degree of "normal" capacity utilization) for a non-accelerating inflation rate.

BOX 3
A DEBT DEFAULT DECADE

The debt defaults started with finance minister Delfim Netto sharply underestimating the domestic debt "inflation adjustment factor" in 1980.[19] There followed the same minister's "negotiated" default on the external debt in December 1982. Next in line were three successive "heterodox stabilization shocks" during the Sarney (1985-1989) Government, which temporarily suspended the "inflation adjustment factor" on domestic debt. In early 1987, Sarney declared a unilateral default on external public debt. The biggest domestic debt default of all was the freezing for one year of nearly all domestic financial assets at the start of Collor's Government (1990-1992).

Subsequently to such successive debt defaults (which interrupted only temporarily the growth of public debt in Brazil) there occurred a substantial increase both in the country's risk internationally and in the real domestic rate of interest. An explanatory hypothesis is that the sequence of debt defaults raised both the required real interest rate and the required return on capital. This would have resulted in a higher desired mark-up over variable cost, thus tending to accelerate the rate of inflation for a given unemployment rate (or, equivalently, for a given capacity utilization rate). The implication is that the non-accelerating inflation rate of unemployment (or, equivalently the "normal" rate of idle capacity) would be higher than before.

The increase in Brazil's tax burden from the early 1990s would be second in line as a possible cause of the increase in idle capacity. A sharp rise in the share of "informal labor" in total urban employment in the 1990s accompanied this process. A plausible hypothesis is that the increased "tax wedge" displaced economic activity from the more productive formal sector to the less productive informal sector, thus reducing the use of the installed capacity in the formal sector.

At a more general level, the 1988 Constitution, coupled with subsequent legislation and judiciary decisions, seems to have increased the precariousness of the economic regulatory framework and, particularly, the uncertainty of contractual relations. A less trustworthy legal framework may also have raised the volatility of production and the "normal" level of idle capacity.

In synthesis, our tentative hypothesis is that this series of post-1980 distorting policy interventions might have led to a higher degree of idle capacity since then.

8 GROWTH ACCOUNTING: A SYNTHESIS

As illustrated in Figure 10, most of the time Brazil was outside the steady state, with v continuously chasing a moving v_{ss}. We have also seen that the rate of convergence of v towards v_{ss} is very slow. This justifies centering our attention on the behavior of the

19. Brazil's domestic debt was typically issued as a fixed-rate note placed at a discount over face and carrying an "inflation adjustment factor" to compensate the debt-holder for increases in the general price index.

capital stock and the GDP growth rates outside the steady state, in a synthesis of Brazil's growth experience.

We start by defining six distinctive epochs broadly characterized by common economic policies or performance. These periods are as follows:

1. War-end and post-war prosperity: 1942-1952.

2. Kubitschek era and its aftermath: 1952-1965.

3. Brazilian authoritarian "miracle": 1965-1974.

4. External shocks and the waning of the military: 1974-1984.

5. Hyperinflation: 1984-1993.

6. *Real* era: 1993-2002.

In Table 5 we decompose the capital stock growth rates for each of these epochs, and in accordance to equation (5), into its components *u* (capacity utilization), *v* (output to capital-in-use ratio), *p* (relative price of investment), and *s* (saving rate).

The table confirms that capital stock growth proceeded at very fast rates up to the mid-1980s, peaking in the "miracle" years (1965-1974). But the behavior of its components changed markedly depending on the phase considered. Thus, average capacity utilization remained at high levels during the first three phases (1942 through 1974), but declined sharply afterwards, especially in the 1974-1984 period. The output to capital-in-use ratio, ***v***, fell throughout the period, and its downward trend was also accentuated in the 1974-1984 decade. The relative price of investment, in turn, rose continuously in all periods, and particularly strongly since 1984.

TABLE 5
DECOMPOSITION OF CAPITAL STOCK GROWTH RATES

Periods	K'	u	v	p	s
1942-1952	0.077	0.969	0.591	0.615	0.122
1952-1965	0.076	0.971	0.492	0.632	0.154
1965-1974	0.088	0.968	0.468	0.651	0.190
1974-1984	0.078	0.940	0.408	0.751	0.222
1984-1993	0.031	0.915	0.355	0.978	0.210
1993-2002	0.024	0.943	0.340	0.993	0.196

From the last column in Table 5 we grasp that the saving rate, *s*, was the main source of capital stock dynamism until the early 1980s: it increased substantially from the early 1940s to 1974-1984, accompanying a big build-up of foreign debt in this last period. Had it not been for the increase in *s*, the yearly capital stock growth rate in 1974-1984 would have been much smaller, because of the opposing forces represented by lower capacity utilization, diminished output to capital-in-use ratio, and higher prices of investment.

The collapse of capital stock growth after 1984 is explained mainly by the very adverse behavior of p, the relative price of investment. Also collaborating were declines in u and, especially, v-s remained nearly unchanged.

A decrease in savings helps to explain the bad performance of K' in the last period in the table (1993-2002), together with declines in v and $1/p$. Capacity utilization, in turn, contributed to increase K'.

In summary, the main culprit of the slump in capital accumulation in the last 20 years seems to have been the rise in the relative price of investment. A simple exercise illustrates this conclusion. Suppose that p had remained through 2002 at its average level in the "miracle" period, 1965-1974, that is, 1/3 lower than the value observed in the 1984-2002 period. Then, ceteris paribus, the average capital stock growth rate would have been twice as high in 1984-2002. Recall that the phenomenon of a rising p was a Brazilian peculiarity, probably related to the economic insulation of the post-1974 period. Our tentative conclusion, thus, is that a more sensible response to the economic shocks of the 1970s would have avoided the plunge in capital accumulation observed over the last two decades.

Two alternatives to decompose GDP growth are discussed next. The first is according to the so-called "$Y = AK$ model", as presented by Bernanke and Gurkaynak (2001). They start from a neo-classical production function of the form:

$$Y = (uK)^{\alpha} (\tilde{A}hL)^{1-\alpha} \tag{8}$$

Where:

Y = real GDP;

$u.K$ = real capital stock in use;

$\tilde{A}$ = exogenous technological factor;

h = labor skill content;

L = employment;

α = elasticity of output with respect to capital; and

$1 - \alpha$ = elasticity of output with respect to effective labor.

Along the lines of Kenneth Arrow's classical "learning by doing" 1962 article, Bernanke and Gurkaynak suppose that worker skills are proportional to the capital-in-use to labor ratio, i.e., $h = u.K/L$. Then, the production function simplifies to:

$$Y = v.u.K, \tag{9}$$

where:

$$v = \tilde{A}^{1-\alpha}$$

This decomposes, in terms of growth rates, approximately as:

$$Y' = v' + u' + K' \tag{10}$$

The results of this decomposition are shown in Table 6, according to the same previously identified periods. The main finding in Table 6 is that the collapse of GDP growth in 1974-1984 predated by one decade the fall in capital accumulation, which occurred only after 1984. In 1974-1984, declining levels of capacity utilization and a rapidly decreasing output to capital-in-use ratio were responsible for a GDP growth rate half as large as the capital stock growth rate. The 1981-1983 debt crisis, induced recession, together with the highly capital intensive industrialization drive of the period, share responsibility for this, as indicated by the negative values of u' and v' in 1974-1984.

TABLE 6
DECOMPOSITION OF OUTPUT GROWTH RATES—AK MODEL

Periods	Y'	K'	u'	v'
1942-1952	0.069	0.077	0.005	−0.011
1952-1965	0.064	0.076	−0.004	−0.008
1965-1974	0.095	0.088	0.009	−0.002
1974-1984	0.039	0.078	−0.011	−0.025
1984-1993	0.025	0.031	0.002	−0.008
1993-2002	0.027	0.024	0.002	0.001

Table 6 thus shows that, although the most proximate cause for GDP growth was capital stock growth, changes in capacity utilization and in the output to capital-in-use ratio were important determinants as well. Thus, one of the factors behind the "Brazilian economic miracle" was an increasing degree of capacity utilization, since changes in v actually contributed to lower the GDP growth rate. The modest recovery in GDP growth observed in 1993-2002 was also influenced by an increasing capacity utilization (plus a slightly increasing v), as capital accumulation growth continued to decline.

The second approach to decompose GDP growth is according to a more traditional Solow-Swan (SS) production function:

$$Y = (u.K)^{\alpha} (A.L)^{1-\alpha} \quad (11)$$

where A is labor-augmenting technical progress or simply total factor productivity (TFP).

The main contribution of the Solow-Swan model was to uncover a process of adjustment to a steady state, in which only the growth of effective labor matters. To stress this result, we rewrite equation (11) in the following alternative way:[20]

$$Y = (1/v)^{\alpha/1-\alpha}(A.L) \quad (12)$$

20. Equation (12) is being extensively used in recent literature dealing with international differences in income levels. For a summary, see Romer (2001, pp. 138-140).

where:

$$1/v = u.K/Y = (u.K/A.L)^{1-\alpha} \tag{13}$$

Equation (11) "explains" GDP by effective labor, $A.L$, adjusted by a time-varying factor, $1/v$. This variable, as equation (13) makes clear, is not a technological datum in a SS context, but simply a (power) function of the ratio of capital-in-use to effective labor.

From (12) we derive the following approximation to the decomposition of GDP growth, assuming $\alpha = 0.5$:[21]

$$Y' = (1/v)' + A' + L' \tag{14}$$

As can be inferred from equation (13), $(1/v)'$ stands for capital deepening (i.e., the difference between the capital stock-in-use growth rate and that of effective labor.) Equation (14) shows that, outside the steady state, capital deepening shares with the effective labor growth rate the explanation for GDP growth.

Before entering the numerical exercise, it is worth exploring the differences between (10) and (14). In one case (AK), v' is positively contributing to GDP growth; while in the other (SS), it is its inverse, $(1/v)'$, that has a positive contribution to make. This role reversal is not difficult to explain. In (10), the critical variable for GDP growth is capital accumulation. To this we need to add the rate of change of capital productivity (i.e., v') to obtain the output growth rate. In (14), the critical variable is the growth rate of effective labor ($A.L$). To this we need to add capital deepening [i.e., $(1/v)'$], or the additional contribution of capital accumulation, to obtain the growth rate of GDP.

Table 7 shows the results of this alternative decomposition, expressed by equation (14). We added a last column to show the share of GDP growth explained by TFP.

TABLE 7
ALTERNATIVE DECOMPOSITION OF OUTPUT GROWTH RATES—SS MODEL

Periods	Y'	$(1/v)'$	L'	A'	A'/Y' (%)
1942-1952	0.069	0.011	0.021	0.035	51.1
1952-1965	0.064	0.008	0.024	0.031	47.9
1965-1974	0.095	0.002	0.034	0.057	59.6
1974-1984	0.039	0.026	0.031	–0.017	–43.5
1984-1993	0.025	0.008	0.025	–0.008	–32.0
1993-2002	0.027	–0.001	0.016	0.012	43.1

The most important aspect of this table is to stress the crucial role of $(1/v)'$ to explain GDP growth in 1974-1984: capital deepening (2.6% per year) was the main

21. This convenient value is consistent with the income share of capital in Brazil's national accounts. It is also in accordance with the country's very high income concentration. Other recent studies of Brazil's growth experience have used values for α in the range of .35 to .50 [see Pinheiro et al. (2001), Ellery Jr. et al. (2003), and Gomes, Pessôa and Veloso (forthcoming)]. The adoption of values in this range would not materially change our conclusions.

factor to sustain a GDP growth rate of 3.9% per year in this period, as effective labor grew 1.4%. Moderate as it was, GDP growth in the last decade of the military regime could be maintained mainly on the basis of very high doses of capital deepening, financed by external debt accumulation.[22]

In both 1965-1974 and 1993-2002 the contribution of capital deepening was very small or nill. But this does not mean that the economy was in a stable steady state. The reason why not is that v_{ss} did not remain constant in these periods, as shown in Figure 10.

The importance of TFP change varied substantially through time, reaching negative values both during the external shocks period (1974-1984)—when an amazing –1.7% per year rate of decline was observed—and in the hyperinflation years (1984-93). In the remaining periods, it represented a substantial share of GDP growth, with a high of 60% in the "miracle" years.

In the Cardoso years, had it not been for the recovery of A' (1.2% yearly, against –0.8% in the previous period), GDP growth would have been only 1.5%, instead of the observed 2.7% per year. Thus, from the perspective of TFP change, the two "lost decades" were not the 1980s and the 1990s but, rather, the decadal periods of 1974-1984 and 1984-1993—the long and tormented transition from dictatorship to democracy, characterized by debt accumulation and hyperinflation.

In the *Real* period, moreover, the contribution of raw labor, L', is very low—a fact related not to a decline of labor force growth, but to a reduced labor absorption. A possible explanation is that the rhythm of capital accumulation did not accompany that of technical progress, thus generating fewer employment opportunities. With GDP growth constrained by capital accumulation, something had to give in the SS decomposition: since A' was creeping upward, L' had to adjust to levels inferior to N'. An analysis of the behavior of employment, however, will have to be left to another occasion. These series are not part of the Brazilian system of national accounts. Moreover, besides being available only for 10-year intervals, they are of dubious quality (or comparability), even in Census years.

For reference purposes, Table 8 depicts the ratios of employment to the working age population in the Census years, as well as the average decadal growth rates of these variables.

TABLE 8
EMPLOYMENT (*L*) AND WORKING AGE POPULATION (*N*): CENSUS YEARS

Years	*L*/*N*	*N*' (average)	*L*' (average)
1940	0.509	n.a.	n.a.
1950	0.481	0.021	0.015
1960	0.467	0.032	0.029
1970	0.430	0.031	0.022
1980	0.481	0.029	0.041
1991	0.490	0.023	0.025
2000	0.479	0.022	0.019

22. External debt as a ratio to GDP increased to 43.1% in 1984 from 16.3% in 1974, while the ratio of debt service to merchandise exports zoomed up to 102.3% from 33.4% [see Gordon (2001, Tables 3.1 and 3.2, p. 76-77 and 86).

9 CONCLUSIONS

The following summarizes our main policy-related conclusions. After an historical overview, we provide estimates of Brazil's current growth potential.

9.1 HISTORICAL SKETCH

Unveiling the mystery of post-1980 Brazil's growth slump requires going back to the early 1970s, perhaps the early 1950s. On both occasions, the country was hit by long-lasting adverse terms of trade shocks: a coffee price slump in one case, an oil shock in the other.

The policy responses to the resulting foreign exchange scarcity could have mimicked those of the Southeast Asian countries, and focused on increasing the "exportability" of the economy—thus reducing the country's dependency on coffee exports in the 1950s, and paying for dearer oil imports in the 1970s.

Export pessimism associated with the lobbying interests of coffee growers and inward-oriented industrialists prevented this from happening in the early 1950s. Instead, coffee valorization and industrial protectionism maintained the country's dependency on coffee exports while generating a major import substitution industrialization (ISI) drive. The seeds of economic inefficiency were thus introduced into the Brazilian economy, in the form of an increasing cost of investment goods and a declining productivity of capital. A caveat, however applies: the productivity of capital decreased in most countries, as we have seen, albeit not as much as in Brazil; peculiar to Brazil is the association of this decline with a sharp rise in the price of investment goods.

Industrial protectionism under President Kubitschek (1956-1960) was associated to the promotion of foreign direct investment. This increased the rate of absorption of technical progress and succeeded in maintaining the growth impulse inherited from the 1940s. Political convulsion in the early 1960s temporarily interrupted this process.

The technocrats coming to power with the military coup of 1964 introduced major tax and financial reforms, while maintaining a friendly attitude towards foreign capital. The resulting saving and investment boom, associated to a high rate of technical progress, became known as the "Brazilian economic miracle" of the 1965-1974 period.

An overextended economy was hit by the oil shock of the early 1970s. This time it was the need to legitimize through short-term economic success a statist authoritarian regime that determined a renewed emphasis on heavy ISI, financed by sharp external debt accumulation. This unfortunate course of action led the relative price of investment to increase by 30% and the productivity of capital to decline by 21% from 1974 to 1984. Technical "regress" rather than progress was the characteristic of this period. Moreover, continued international adversity eventually forced the country into a default on its external obligations in late 1982.

The political euphoria with the return of democracy in 1985, catapulted by the short-term success of a wage and price freeze in 1986, obscured the economic inefficiencies inherited from the military regime. This fed into a sequence of failed "heterodox" stabilization experiments and debt defaults, while a new populist Constitution was promulgated in 1988—thus making the country nearly ungovernable. An uncertain political and economic environment apparently contributed to raise the degree of idle capacity. Compounded with the economic inefficiencies of ISI, this accentuated the economic slump while inflation accelerated.

Hyperinflation broke out but was eventually dominated in 1994. This opened the way under President Cardoso (1995-2002) for a radical departure from the statist ISI model that prevailed under the military. But a lax fiscal stance and excessive reliance on a dollar anchor (which required high real interest rates) crowded out exports and private investment, thus preventing a sustained economic recovery from taking place. It was only after the foreign exchange crisis of late 1998-early 1999 that a more sensible macroeconomic policy tripod was put into place: a large primary fiscal surplus, an inflation targeting monetary policy, and a floating exchange rate.

The structural reforms of the Cardoso Government managed to stop the long-term processes of increasing cost of investment and declining productivity of capital, while raising capacity utilization without rekindling inflation. Technical progress resumed, probably as a consequence of import deepening and privatization, but this was not sufficient to generate sustained growth, even after 1999, for capital accumulation was held back by a succession of adverse shocks: domestic energy crisis, Argentine's default, and the specter of a left-wing Lula presidency.

9.2 BRAZIL'S GROWTH POTENTIAL

In his first year in government, instead of attempting a populist return to the "statist" closed economy model of the past—as many have feared—President Lula maintained intact the post-1999 macroeconomic policy tripod. He also continued to reform the unwieldy legal edifice that was erected by the 1988 Constitution. Presuming that this stance will be preserved in the coming years, it seems useful to summarize the implications of the empirical results of this paper for the enhancement of Brazil's growth potential.

Our conclusions vary depending on which model is used. In an AK perspective, presuming that the degree of capacity utilization, u, and the output to capital-in-use ratio, v, are constant, GDP growth potential can be approximated, as in equation (10), by the growth rate of the capital stock, K'. This can be written according to equation (5) as:

$$K' = s(1/p)uv - \delta \tag{15}$$

Current values for the right hand variables are approximately as follows: total saving rate (s) = 0.19; relative price of investment (p) = 1.0; average degree of capacity utilization (u) = 0.93; productivity of capital (v) = 0.34; and capital stock depreciation rate (δ) = 0.039. Plugging these values in the previous equation gives K' = 2.1%. This would be Brazil's current growth potential, according to the AK model.

From the steady-state perspective of the SS model, GDP growth is constrained by the sum of labor force growth, N' (currently 2.1% per year) with the rate of total factor productivity growth, A', which was on average of 2.2% in the 2000-2002 period. This yields a potential GDP growth rate of 4.3%.

From the fact that the growth rate of the capital stock, K', is lower than the growth rate of effective labor, $A' + N'$, it follows, in a Solow-Swan context, that the short-run growth rate of output is lower that its steady-state value. With $\alpha = 0.5$, this short-run GDP growth rate can be obtained from equation (11), assuming u constant, and $L' = N'$, as a simple average between the growth rate of effective labor, 4.3%, and the growth rate of the capital stock, 2.1%, i.e., it is 3.2% per year. This would be short-run (potential) GDP growth rate according to the Solow-Swan model.

Let us start from the lower end of these estimates, assuming v constant, in which case the short-run potential GDP growth is limited by capital formation (as in the AK model), i.e., 2.1%. Consider the currently observed degree of capacity utilization, $u = 0.93$. Our results suggest an average level of capacity utilization of 0.95 for a period such as 1995-2000. This means that, as inflation converges to the long-term government target, there would be room for a moderate demand-pull growth spell. If such higher level of $u = 0.95$ could be sustained on a permanent basis, this would permit only a very modest rise of the capital growth rate to 2.2% (against the previously calculated 2.1%).[23]

More to the point, perhaps, would be dealing with the relative price of investment, p. Introducing market contestability seems to be a sensible course of action here: a fuller opening up to capital goods imports (for example, doing away with the remnants of the infamous 1984 "informatics law"), together with sensible pro-competitive policies, could have an important impact.[24] Thus, for example, if it were possible to make p return to values observed in the mid-1980s ($p = 0.8$), the capital stock growth rate would rise from the previously calculated 2.2% to 3.8%, ceteris paribus.[25]

There remains the total nominal saving rate, s, which has been hovering around 20% for the past two decades—with the remarkable exception of the higher values in the hyperinflation years. A higher domestic saving rate can be achieved in the medium to long term, as confidence-building measures increase private savings and the imbalances in the public sector accounts are dealt with in a lasting way.

The above exercises indicate that it is not difficult to imagine courses of action to make the capital accumulation growth rate to move up to 4.2%, at which point it would encounter the SS steady state technical progress constraint. To go further than

23. According to equation (10), increasing u from 0.93 to 0.95 raises the short term GDP growth rate by approximately 2 percentage points. But this is a once and for all gain if the growth rate of capital accumulation remains constant. The second result is derived from equation (5), i.e., assuming a higher rate of capital accumulation.

24. This is consistent with Rodrik's (1999, p. 27) admonition that: "(...) because developing countries lack a comparative advantage in producing capital goods, trade restrictions in such industries tend to be detrimental to growth. Trade protection raises the relative price of capital goods and reduces the level of real investment that is attainable for any level of savings".

25. This ceteris paribus clause implies that the "effective" saving rate, $s.(1/p).u$, would increase by 4.9 percentage points.

there, we would thus also have to consider ways and means of speeding up the rate of incorporation of technical progress, A'. Our paper has little to offer in this direction. But current literature is aplenty with suggestions, involving higher human capital investment, tax reform, increased tradability of the economy, etc.

9.3 FINAL CAVEATS

A final word of caution is in order. In this paper, we have followed truthfully the commands of the AK and SS models, thus focusing attention on savings and technical progress as alternative but ultimate determinants of GDP growth. We ignored the limits posed by an autonomous investment function, as well as "foreign exchange constraints" possibly reducing Brazil's growth potential.

As to the former, it is our belief that the private sector's "propensity to invest" is unlikely to represent a major impediment to the country's growth rate, provided that remaining doubts about President Lula holding on to sensible economic policies are overcome.

The foreign exchange constraint is a more delicate matter: some may argue that fiscal rectitude and a floating exchange rate are by themselves sufficient to overcome difficulties in this area. We are more skeptical—exchange rate fluctuations are more often than not dictated by the capital account, not the current account, and the former may be subject to bouts of volatility that work against a growth strategy stressing the "exportability" of domestic production.

Moreover, and perhaps more fundamentally, until the country proves able to develop an on-shore long-term capital market, the need for offshore dollar denominated loans is unlikely to go away. Overcoming the jurisdictional uncertainties currently holding down the development of local long-term capital markets would seem to be the way to solve this problem. With this observation, we leave the important topic of jurisdictional uncertainty for treatment elsewhere [see Arida, Bacha and Resende (2004)].

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