

ACCOUNTING FOR THE RISE AND FALL OF POST-WW-II BRAZIL'S GROWTH

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Summary: *Brazil's GDP grew vigorously from the early post-WW-II period until 1980. GDP growth then collapsed and never again recovered its previous performance, not even after inflation was tamed in 1994. With the help of a commodity boom and large capital inflows, growth rates increased after 2004, but remained below those of the pre-1980 period. We investigate this historical process with the help of an accounting framework that emphasizes capital deepening and total factor productivity. A novel feature is the decomposition of capital growth according to a formula involving the savings rates, the relative price of investment, the degree of capacity utilization, and the output to capital-in-use ratio.*

1. INTRODUCTION³

Brazil's economic growth after WW-II can be divided in two major periods, before and after 1980. This is clearly observed in Figure 1, where the bars indicate yearly GDP growth rates from 1948 to 2011. Overlapping the bars, a solid line indicates the 10-year average of the yearly rates, starting in 1957 and ending in 2011. The 10-year average line leaves no doubt: there was a collapse in GDP growth after 1980, from which the country did not fully recover even after inflation was tamed in 1994.

This text examines the long-term evolution of the Brazilian economy with models that emphasize the determinants of aggregate supply. It updates previous work, in which we used the same methodology to help decipher the puzzle of Brazil's growth collapse after 1980⁴.

The paper is organized as follows: the next section provides a historical sketch of the 1947-2011 period, including the main findings of our empirical analysis. Section 3 derives an expression to decompose the capital stock growth rate. This involves savings as well other variables relevant to the growth

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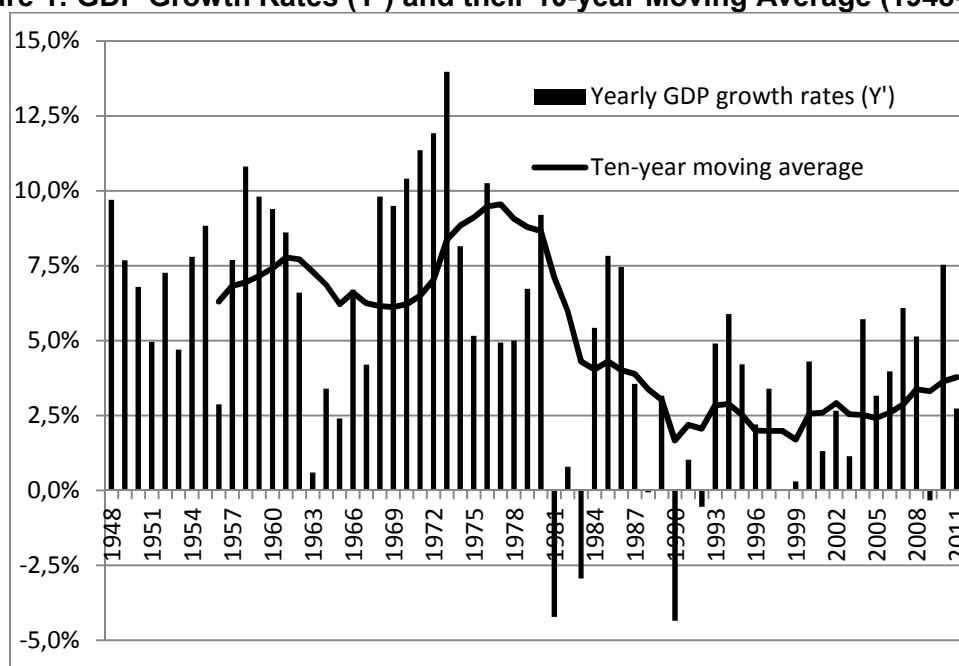
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³ An extensive version of this paper [Bonelli and Bacha (2012)] discusses statistical sources and procedures, in addition to developing themes that are left out of this version.

⁴ See Bacha and Bonelli, 2005. In the present text we also used material from Bacha and Bonelli, 2012.

of capital, as capacity utilization, capital-output ratio, and relative price of investment. Section 4 displays the numerical results of the decomposition of capital growth, seeking to explain in particular the reasons for the collapse occurring after 1980. Section 5 investigates the roles of total factor productivity and capital deepening in the evolution of the GDP per worker growth rate since 1947. Section 6 summarizes the findings.

Figure 1: GDP Growth Rates (Y') and their 10-year Moving Average (1948-2011)



Source: IPEATADA; authors' elaboration.

2. HISTORICAL SKETCH⁵

To unravel the puzzle of Brazil's growth collapse after 1980 we need to go back to the 1970s, perhaps even to the 1950s. On both occasions the country suffered long-term adverse terms-of-trade shocks — a major oil shock in the 1970s, a depression in the prices of coffee in the 1950s. The policy responses to the scarcity of foreign exchange could have mimicked those adopted in Southeast Asia, aiming at increasing the "exportability" of the economy. This would have reduced the country's dependence on coffee exports in the 1950s,

⁵ For the complete story, see the papers collected in Veloso, F. et al. (2012)

and strengthened its capacity to pay for higher oil prices in the 1970s. But the policy responses were of a different nature.

Pessimism about the country's export potential, associated with the influence of coffee farmers and industrialists on the government, favored a strategy of coffee valorization and import substitution in the 1950s. The years from 1952 to 1955 were critical in setting the industrialization pattern that Brazil followed ever since. In 1952, President Vargas (1951-54), under the influence of Finance Minister Horacio Lafer (1951-53), reinstated the pre-WW-II coffee valorization policy as a way to defend an exchange rate which had become overvalued with the end of the Korean war boom. In 1953, Finance Minister Oswaldo Aranha (1953-54) instituted a system of multiple exchange rates, which punished traditional non-coffee exports, protected import substitutes and facilitated the importation of "essential" goods, defined as those without a national similar. To support the movement towards industrialization, a national development bank (BNDE) was created in 1952 and a State monopoly of crude oil (through Petrobras) was established in 1953.

The conservative Vice President Café Filho (1954-55) took over the presidency after the suicide of Vargas in August 1954. His Finance Minister, Eugenio Gudin (1954-55), attempted to undo the coffee valorization scheme but was forced to resign. His successor, José Maria Whitaker (4/1955-10/1955), attempted to dismantle the system of multiple exchange rates only to be dismissed as well. President Café Filho himself was impeached in the so-called democratic anti-coup of November 1955.

With the election of President Juscelino Kubitschek (1956-60), the game was over and Brazil embarked on an import substitution industrialization path that would last until the 1980s. In the process, the relative price of capital substantially increased while the productivity of capital decreased.

Industrial protectionism under President Kubitschek was associated with the promotion of foreign direct investment. This increased the rate of absorption of technical progress and sustained GDP's growth rate. The political upheaval associated with inflation acceleration in the beginning of the 1960s temporarily interrupted this process. The technocrats who rose to power with the 1964 military coup stabilized the economy, introduced economic reforms and raised taxation. The resulting savings and investment boom, associated with a high rate of technical progress, became known as the "Brazilian economic miracle" of the 1965-74 period.

In the early 1970s, an overheated economy was hit by the first oil shock. The obsession with the legitimation of an authoritarian regime through short-term economic success determined a *fuite-en-avant* economic strategy favoring

economic growth and inflation accommodation through indexation. The critical determinant of Brazil's economic future was general Geisel's (1974-79) decision to deal with the 1973 oil shock by promoting a capital-intensive import substitution strategy. This could only be put into practice through a deep dependence on the international recycling of the petrodollars. With the benefit of hindsight, this was an unfortunate choice, because the international scenario deteriorated continuously in the following years. In the domestic economy, a perfected wage indexing formula was adopted as a gradual opening of the military regime started under general Geisel and continued under general Figueiredo (1979-85). Excessive domestic demand and wage indexation strongly increased domestic inflation and the trade deficit. The relative price of investment continued to increase and capital productivity fell substantially between 1974 and 1984. This period was also characterized by "technical regression" rather than by technical progress. A continuously adverse international environment finally forced the country to declare a suspension of external debt payments at the end of 1982.

The financial crisis of the early 1980s put an end both to the military regime and to the country's forced growth strategy. The return to democracy in 1985 took place under accelerating inflation. The political euphoria with democratization, accelerated by the short-term success of a price and wage freeze in 1986, temporarily hid the economic inefficiencies inherited from the military regime. There followed a sequence of failed heterodox stabilization attempts and debt moratoria, while a new populist Constitution was promulgated in 1988 — thus making the country virtually ungovernable.

The debt defaults began in the last stages of the military regime, when Planning Minister Delfim Netto (1979-84) strongly underestimated the inflation-adjustment-index for domestic debt in 1980 (mimicking a strategy that had been adopted by the military regime with the aim of reducing the minimum wage in 1965-67). The same minister followed on with a foreign debt default in December 1982. After redemocratization, President Sarney (1985-89) deployed three successive heterodox shocks that temporarily suspended the inflation-correction of domestic debt. In early 1987, Sarney declared a unilateral moratorium on foreign debt. The largest internal debt moratorium of all was the

freeze for one year of virtually all domestic financial assets at the beginning of President Collor's government (1990-92).

Hyperinflation manifested itself, but was ultimately dominated by the Real Plan in 1994. This paved the way under President Cardoso (1995-02) for a radical deviation from the state-led import substitution model that prevailed in the military regime. But a loose fiscal policy and an excessive reliance on an exchange-rate anchor (which required the support of very high real interest rates) undermined exports and private investment, thus preventing a growth resumption to take place. After a currency crisis that culminated in January 1999, a more sensible macroeconomic policy tripod was adopted: a primary fiscal surplus sufficiently large to keep public debt under control, inflation targeting, and a floating exchange rate. Structural reforms halted the long-term increase in the relative price of investment and the declining productivity of capital. Capacity utilization increased without accelerating inflation. Technical progress again manifested itself, but that wasn't enough to generate sustained growth, even after 1999, because capital accumulation was contained by a succession of adverse shocks: the bursting of the Nasdaq bubble, the internal energy crisis in 2001, September 11, Argentina's moratorium and the specter of a left-wing Lula presidency in 2002.

Rather than attempting a return to the populist state-led closed economy model of the past, as many had feared, President Lula — followed in this by his successor Dilma Rousseff — kept the 1999 macroeconomic policy tripod intact. With the help of a major commodity boom and large capital inflows, the economy recovered after 2004 but proved unable to recover the per-capita GDP growth rates of the pre-1980 period.

With this backdrop, the next sections develop accounting schemes for capital accumulation and GDP growth, thus providing empirical content to the historical narrative above.

3. CAPITAL GROWTH DECOMPOSITION

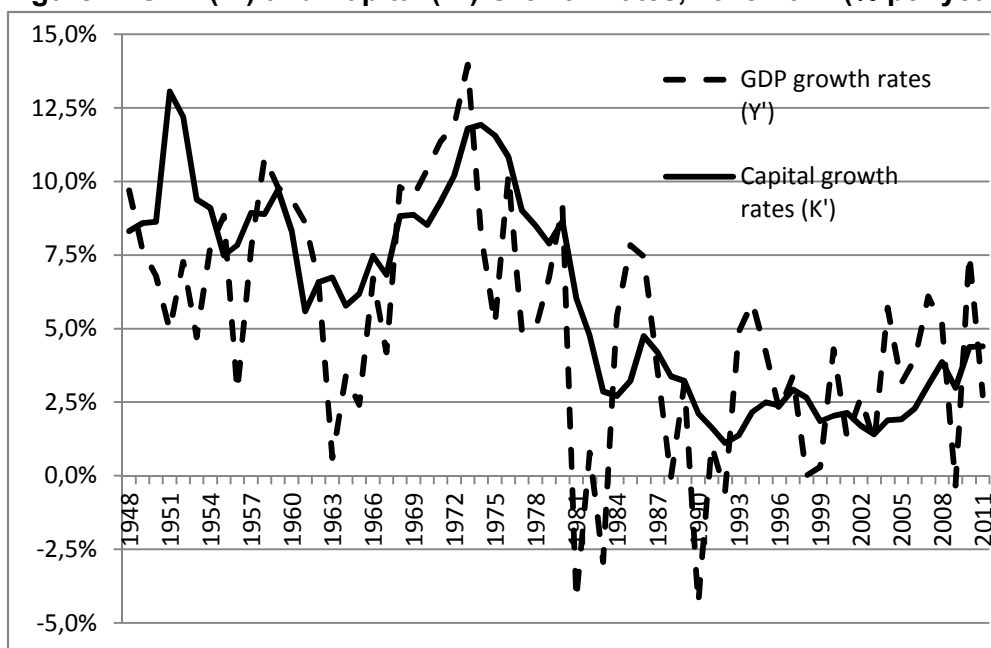
This section first discusses the association between the growth rates of GDP and capital. The purpose is to motivate interest in a decomposition formula for the capital stock growth rate, involving the savings rate, the relative price of investment, the degree of capacity utilization, and the output/capital-in-use ratio.

An empirical analysis of the behavior of these parameters is the object of the rest of the section.

3.1 Relationship between GDP and capital growth

A notable aspect of Brazil's GDP growth is that it is closely associated with the evolution of the capital stock, as evidenced in Figure 2.

Figure 2: GDP (Y') and Capital (K') Growth Rates, 1948-2011 (% per year)



Source: IPEADATA with authors' elaboration.

Figure 2 makes it evident that the collapse in GDP growth occurred along with that of the capital stock. The correlation coefficient between the two series is 0.63. But the existence of a correlation tells us nothing about causation between the variables. We used the Granger test to verify the existence and direction of causality between the series. The results suggest that capital growth Granger-causes GDP growth with a p-value of 4%. On the other hand, GDP growth also Granger-causes capital growth — but only with a p-value of 9.1%. This indicates that capital growth Granger-causes GDP growth more strongly than the other way around. These results are consistent with the Solow model outside the steady-state.

The next step is to identify the factors explaining capital stock growth. The starting point is the definition of the capital stock growth rate as the ratio of gross fixed investment to the capital stock less the depreciation rate:

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

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

In this equation, the ratio of gross investment to capital stock (I/K) can be written as the product of the investment rate (I/Y) by the output-capital ratio (Y/K):

$$I/K = (I/Y)(Y/K) \quad (2)$$

On the right-hand side of (2), the investment rate (I/Y) is identically equal to the product of the saving rate by the inverse of the relative price of investment:

$$I/Y = (P_i I/P_y Y)(P_y/P_i) = (S/P_y Y)(P_y/P_i) = s(1/p) \quad (3)$$

where the first equality is only an expedient to introduce the nominal investment rate ($P_i I/P_y Y$), and thus be able to make use of the identity between nominal investment and savings in the second equality. The third equality is merely a consequence of the definitions of $s = S/P_y Y$ and $p = P_i/P_y$, where P_i is the implicit deflator of gross capital formation and P_y is the implicit GDP deflator.

The output-capital ratio (Y/K) in (2) can be written as the product of the capacity utilization rate, u , by the ratio of output to the capital employed, v , as follows:

$$Y/K = u(Y/uK) = uv \quad (4)$$

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

$$K' = s(1/p)uv - \delta \quad (5)$$

Equation (5) shows that the impact of the savings rate (s) on the growth rate of the capital stock (K') depends on the relative price of investment (p), on the degree of capacity utilization (u), and on the ratio of output to the capital employed (v). The rate of depreciation (δ) also needs to be taken into account — except that, as it only varies between 0.038 and 0.040 in the series we use, it does not contribute to explain changes in capital accumulation through time.

In the following, we discuss the empirical construction of the variables s , u , v and p .

3.2 Role of savings (s)

In view of the importance of the savings rate to explain the collapse of capital formation, it is fitting to examine the behavior of the two main components of this rate — external and domestic savings — in order to better understand the evolution of capital formation financing.⁶ Table 1 shows a breakdown of the financing of gross capital formation, using subperiods characterized by some similarity of parameter values and economic policies (as explained in Section 4 below). The breakdown includes gross fixed capital formation (GFCF) and changes in inventories, as well as domestic and foreign savings, all variables measured as ratios to GDP. Differently from the savings concept to be later used in the decomposition of capital growth, in Table 1 the change in inventories is part of the investment to be financed.

In the decomposition of Table 1, foreign savings is defined as in the national accounts, namely, as the excess of imports over exports of goods and services, or the net resource transfer from abroad. This is a narrower concept than the balance of payments deficit in current account (which includes net income sent abroad in foreign savings), but it seems more relevant to the analysis of the contribution of foreign capital to GDP growth.⁷

It is noteworthy in the table that the eight percentage point increase in total savings from the immediate post-WW-II (15.5% of GDP) to the so-called *fuite-en-avant* 1974-80 period (23.6%), is explained mainly by higher domestic savings (up from 15.3% to 21.0% of GDP).

⁶ It was not possible to split domestic savings between government savings and private savings. The government accounts in the National Accounts cannot be used before the 1994 stabilization because, in them, the monetary correction of public debt appears as a current expense, thus generating an absurdly high public sector 'dissaving'. Previous attempts in the literature at eliminating the monetary correction from the public accounts before 1994 unfortunately generated quite contradictory savings estimates for the government in the period.

⁷ See Bacha (1992) for a discussion of this topic.

Table 1: Rates of Capital Formation, Savings and their Components in Selected Periods (% of GDP in current values)

Periods	GFCF* Rate	Rate of capital formation			
		Var inventories	= Total savings	Foreign S	Domestic S
1947-62	14.8%	0.7%	15.5%	0.3%	15.3%
1963-67	15.8%	1.8%	17.6%	-0.7%	18.3%
1968-73	19.5%	1.5%	21.0%	0.9%	20.1%
1974-80	22.6%	1.0%	23.6%	2.6%	21.0%
1981-92	19.2%	0.1%	19.3%	-2.5%	21.7%
1993-99	17.0%	0.5%	17.5%	1.0%	16.5%
2000-11	17.3%	0.7%	18.0%	-1.3%	19.3%

Source: IPEADATA; Totals may not add due to rounding; * Gross Fixed Capital Formation

Table 1 above also shows that total savings collapsed between the *fuite-en-avant* period and the long lost decade (1981-92), having declined by 4.3 percentage points of GDP. Domestic savings varied little. In fact, it rose slightly from 21.0% to 21.7% of GDP. It follows that the fall of capital formation financing was due entirely to a sharp turnaround in the transfer of resources from abroad: from plus 2.6% of GDP in 1974-80 to minus 2.5% of GDP in 1981-92. This change was transmitted to GFCF (which fell 3.4% of GDP). Seen from this angle, the debt crisis, implying a net outflow of resources to abroad, appears as the main villain behind the fall of GFCF between the two periods.

The fixed investment rate continued to fall in the phase of reforms, from 19.2% of GDP in 1981-82 to 17.0% of GDP in 1993-99, but now the villain was the fall of domestic savings (from 21.7% to 16.5% of GDP), this possibly being associated with the end of the inflation tax plus the pressure of current spending on the government budget that led to a reduction in public investment. In the most recent period, a decrease of foreign savings was more than offset by an increase in domestic savings, raising total savings slightly, from 17.5% of GDP in 1993-99 to 18.0% of GDP in 2000-11.

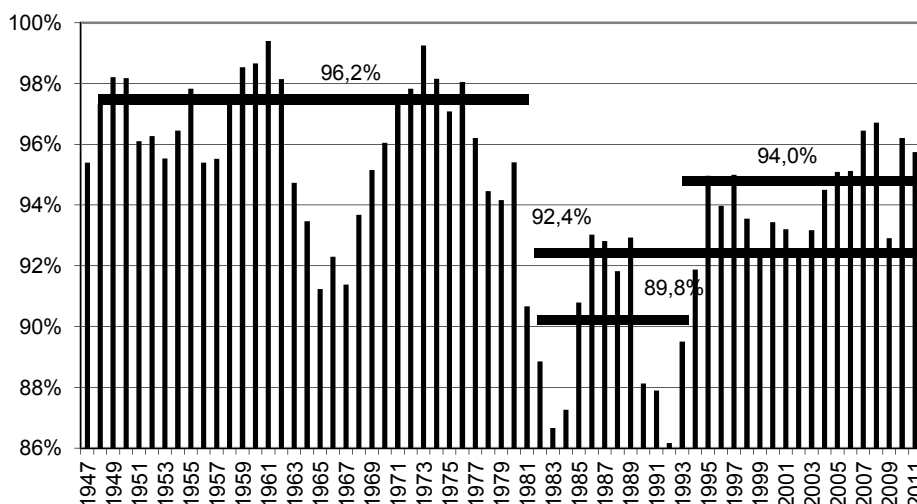
3.3 Degree of capacity utilization (u)

A usually neglected variable in the growth decomposition in (6) is the degree of capacity utilization in the economy (u). In this case there is direct information only for manufacturing industry. The procedure we adopted involves smoothing the movements of capacity use in industry — an activity that is more volatile than the rest of the economy — by incorporating information from other sectors.

According to these estimates, shown in Figure 3, the highest level of capacity utilization occurred in 1961 (99.4%) and the lowest in 1992 (86.2%). From 2002 on utilization rates increase, reaching 96.7% in 2008 and decreasing slightly to 95.7% in 2011.

The figure also shows capacity utilization averages in selected subperiods. It is noticeable that the average utilization rate falls from 96.2% in 1947-80 to 92.4% in 1981-2011. Thus, not only capital and GDP growth collapsed after 1980, but also average capacity utilization fell almost 4 percentage points. Subdividing the years 1981-2011 in two phases, the utilization rate is seen to exhibit an upward movement from 89.8% in 1981-1992 to 94.0% in 1993-2011, for a gain of 4.2 percentage points. Still, capacity utilization remains below the 96.2% average recorded in 1947-1980.

Figure 3: Capacity Utilization in the Brazilian Economy (u), 1947-2011 (%)



Source: Our calculations. See extensive version of the paper.

3.4 Output/capital in use ratio (v)

The evolution of the ratio between real GDP and capital in use is shown in Figure 4. It is characterized by two long declining stretches, the first from 1947 to 1959 (when it falls from 0.8 to 0.62), the second from 1973 to 1983 (when it falls from 0.61 to 0.46). Towards the end of the series, v increases a little, from 0.44 in 2001-03 to 0.48 in 2009-11, in tandem with GDP growth.

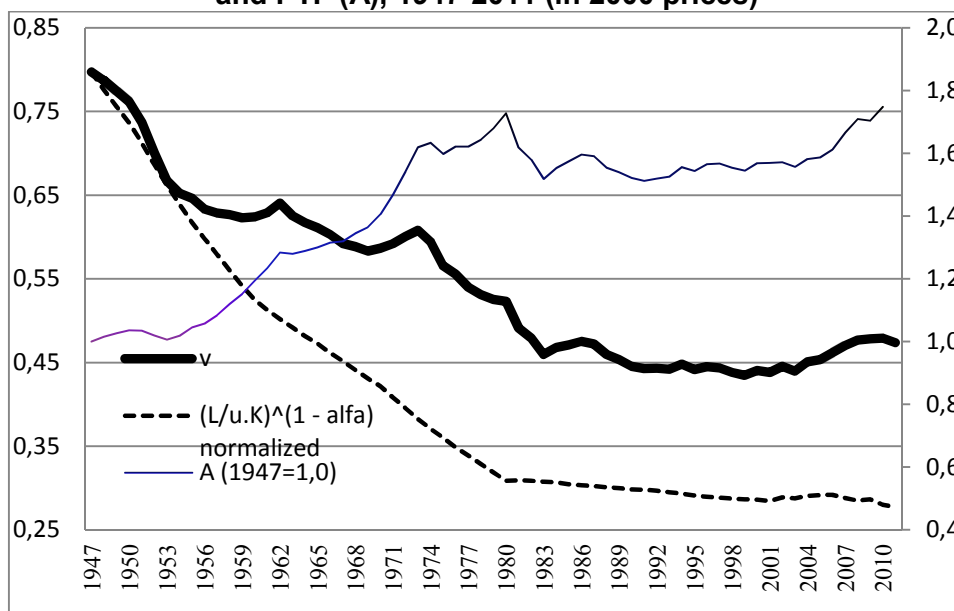
A neoclassical explanation for the fall of v emphasizes the relationship of this variable with the evolution of the labor/capital ratio. Using a Cobb-Douglas aggregate production function with the usual properties, one can write the output/capital-in-use ratio as:

$$v = Y/uK = AL^{1-\alpha} (uK)^\alpha /uK = A(L/uK)^{1-\alpha}$$

where α is the elasticity of output with respect to capital, L is the labor force, and A is total factor productivity (TFP). Thus, in this interpretation, v is equal to the product of the rate of technical progress by the labor/capital-in-use ratio raised to the power $1-\alpha$.

Figure 4 illustrates the behavior of three variables, v , $(L/uK)^{1-\alpha}$ and A , from 1947 to 2011. In the figure, we normalized the expression for the labor/capital-in-use ratio, equating it to the value of v in 1947 (both are read on the scale to the left). The series for A also appear with 1947 = 1.0, and should be read in the scale to the right.

Figure 4: Output/capital in use ratio (v), labor/capital in use ratio raised to $1-\alpha$, and PTF (A), 1947-2011 (in 2000 prices)



Sources: see expanded version.

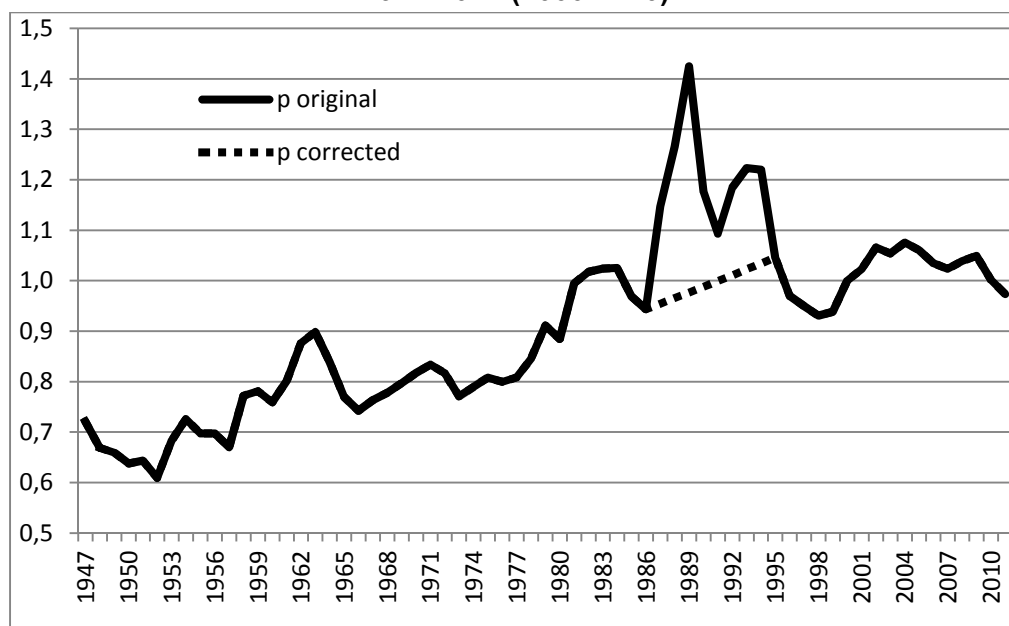
The figure shows that v declines most of the time following the decline of the labor/capital ratio, which is a consequence of capital accumulation

exceeding employment growth until the early 1980s. Total factor productivity growth holds down the decline of v in the initial period. Starting in 1974, total factor productivity grows more slowly, or even decreases, as in the 1980s. After 1980, the pace of capital deepening slows down and, consequently, the output to capital-in-use ratio tends to stabilize. It grows moderately again in the 2000s.

3.5 Relative price of investment (p)

The relative price of investment p – the ratio between the implicit deflators of GFCF and GDP -- plays a key role in explaining the capital growth plunge. Figure 5 shows that the behavior of the relative price of investment in Brazil is peculiar, indeed. Aside from an anomalous performance in 1987-94, which we discuss below, it follows a trajectory of continuous expansion. A simple exponential trend line indicates that the relative price of investment grew at a rate of approximately 0.7% per annum for more than sixty years!

Figure 5: Relative Price of Investment, Original and Corrected 1947-2011 (2000 = 1.0)



Sources: FGV, IBGE and authors' elaboration.

A hypothesis that seems plausible for the anomalous behavior of p between 1987-94 is that after the price unfreezing that followed the failure of the 1986 Cruzado Plan, entrepreneurs adopted a defensive stance against possible future freezes, and began reporting to the Vargas Foundation the list price for their machines and building supplies, which tend to be higher than the prices

they actually charged. In other words, the initial jump of p in 1987 was just a statistical phenomenon. There followed much turbulence, both in the country's economy and in the national statistics, at the end of the decade. Thus, a measurement error, caused by the capture of inflated listed prices, may have been propagated to subsequent years until a thorough National Accounts was made for the period after 1994.

Assuming that measurement errors and changes in National Accounts methodology are behind the anomaly of the p series from 1987 through 1994, we propose henceforth to adopt a correction for this variable. Between 1987 and 1994, we suggest replacing the p series that is obtained from the National Accounts by a geometric interpolation of values between 1986 and 1995, as indicated by the dotted line in Figure 5. Therefore, the corrected series retains all the original values from 1947 to 1986 and from 1995 to 2011, changing only the figures for the intermediate years.⁸

We succeeded in explaining the long-term behavior of the corrected p series with a multiple regression, with three independent variables: the share of imported machines on all machinery and equipment entering capital formation, the real exchange rate, and a trend. The regression results in Table 2 have a R^2 of 0.89, denoting an excellent statistical adjustment. The coefficients of all independent variables have the expected signs and plausible values.

Table 2: Regression Statistics with p -corrected as Dependent Variable

Dependent variable:				
p corrected	Coefficient	Stand. error	t-stat	P-value
Intercept	0,6280	0.0326	19.28	0.000
Imported mach/total machines	-0.1218	0.0501	-2.43	0.018
Real exchange rate	0.1137	0.0287	3.95	0.000
Time trend	0.0058	0.0003	16.95	0.000
R squared	0.8913	64 obs..	(1947-2010)	
R square adjusted	0.8859			
Durbin-Watson statistic	0.6224	P-Value	0,000004	

Source: see text

⁸ In the Brazilian National Accounts, the nominal savings rate is calculated residually, simply as the product of the price index for investment goods by the volume index of investment. Hence, the correction of the price index series also requires that we correct the nominal saving series for the 1987-1994 period. For more details, see the extended version of this paper.

The negative coefficient of the share of imported machinery reveals the cost of the import substitution of capital goods. The inclusion of the real exchange rate in the regression is explained by the importance of the import component of investment: the more depreciated the exchange rate, the higher the price of investment relative to GDP. The coefficient of the time variable implies that there is a progressive rise in the relative price of capital goods in the country, even after allowing for the higher cost of import substitution and the vagaries of the real exchange rate. We believe that this is a result of the low pace of productivity growth in the construction industry: labor productivity in the construction industry grew approximately 1.0% per year between 1950 and 2008; for the economy as a whole the rate was 2.3%.

4. CAPITAL GROWTH COLLAPSE DECOMPOSED

In Table 3, capital growth is decomposed according to the expression (5) obtained in the previous section. The results follow a periodization that favors the identification of periods with similar characteristics of economic performance and economic policies, namely:

1948–62: post-war prosperity and the Kubitschek-era

1963–67: recession and defeat of democracy

1968–73: authoritarian economic 'miracle'

1974–80: oil shock and *fuite en avant*

1981–92: debt crisis and lost decade

1993–99: Real Plan and economic reforms

2000–11: New macroeconomic regime

Table 3: Breakdown of Capital Growth (K') – Annual Averages in Selected Periods (1948-2011)

Periods	K' (% per annum)	s (% GDP)	u (%)	v	1/p (=1.0 in 2000)
1948-62	8.9	14.8	97.1	0,683	1,415
1963-67	6.6	15.8	92.6	0,610	1,252
1968-73	9.6	19.5	96.5	0,593	1,248
1974-80	9.8	22.6	96.2	0,548	1,201
1981-92	3.3	19,2	89.8	0,463	1,012
1993-99	2.3	17,0	93.1	0,442	1,018
2000-11	2.7	17,3	94.6	0,459	0,969
Total	6.0	17,7	94.4	0,547	1,164

Source: see text

Two major periods are clearly characterized in the table: before and after 1980. Between 1947 and 1980, the growth of the capital stock is strong in all the subperiods, reaching 9.8% per annum in the *fuite-en-avant* period. Even in the political crisis that gave end to the 2nd Republic and initiated the military regime (1963-67), the capital stock growth was relatively high: 6.6% per year.

After 1980, capital stock growth falls sharply, not recovering even after hyperinflation was conquered by the Real Plan in 1994. Part of the responsibility lies on the savings rate (s), which fell more than 3 percentage points due to the reduction of foreign savings (see section 3.2). The three other factors behind the collapse of capital accumulation between 1974-80 and 1981-92 are: a decrease in capacity utilization (u) of 6 percentage points, a fall in capital productivity (v) of 8 percentage points, and an increase in the relative price of investment (p) of almost 19%. That is, even after correcting the figures for the relative price of investment as described previously, it continues to be an important determinant of the collapse of capital formation after 1980.

The capital growth rate continued to fall between the long 'lost decade' of 1981-92 and the short 1993-99 phase of reforms. The main responsibility for this was a reduction in the domestic savings rate, as explained in Section 3.2. Finally, between the age of reforms and the growth resumption of 2000-11, there occurs a modest acceleration in capital formation that is explained mainly by increases in use of installed capacity and the productivity of capital.

5. CAPITAL DEEPENING, TFP AND THE COLLAPSE OF GDP GROWTH

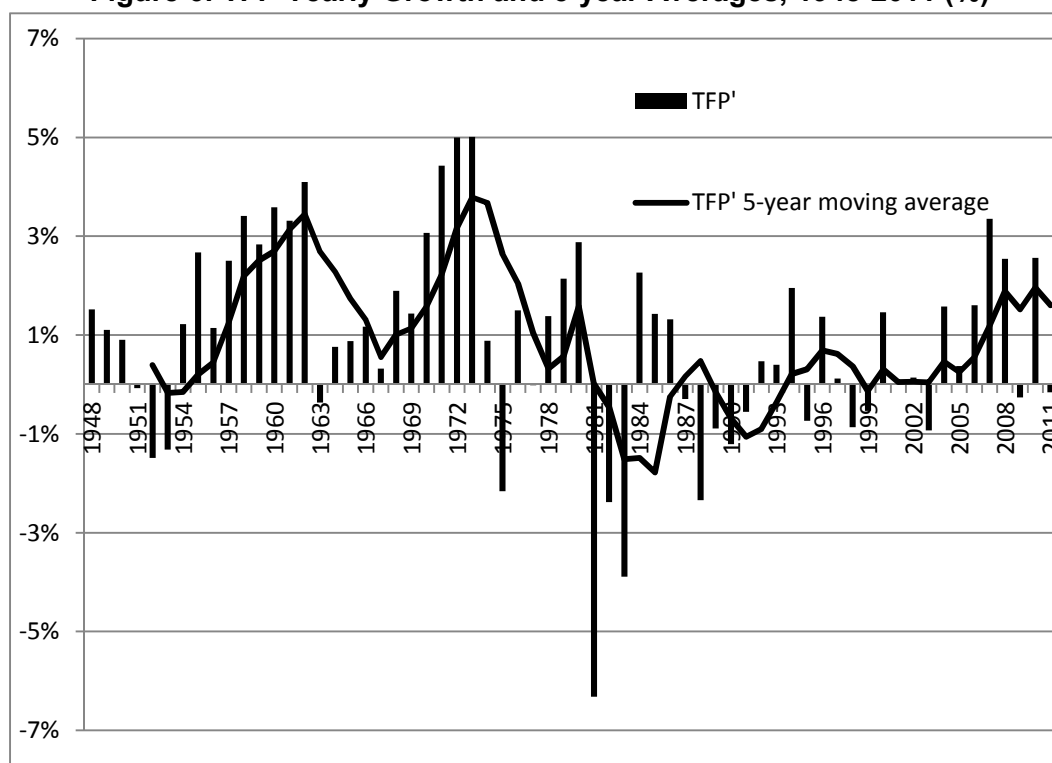
The purpose of this section is to develop a growth decomposition exercise, by using an aggregate Cobb-Douglas production function, with capital and labor as production factors. Our interest is in the evolution of GDP per worker. The log-linearization of a function of this type results in:

$$y' = \alpha (uk)' + \text{TFP}' \quad (6)$$

where y' is the growth rate of GDP per worker, α is the capital share in GDP, $(uk)'$ is the growth rate of capital employed per worker, and TFP' is the rate of growth of total factor productivity.⁹

Figure 6 presents the TFP' series, obtained residually from equation (6). It is seen that TFP' varied enormously over time. The average rate of change of TFP varies from a low of -1.0% per annum in the lost decade (1981-92) to a high of 3.3% per year in the "economic miracle" period (1968-73). The average for the entire period is nearly 1% per year. After the lost decade, TFP growth resumed, albeit slowly. From 1999 on total productivity growth is more visible: 1.0% per year in 2000-2011 (see Table 4).

Figure 6: TFP Yearly Growth and 5-year Averages, 1948-2011 (%)



Source: see text

The breakdown of the sources of GDP per worker growth (y') according to equation (6) is presented in Table 4.

⁹ As explained in the extensive version of this paper, we adopted the value of 0.46 for the coefficient α . This is almost identical to the value estimated by Considera and Pessoa (2012).

Table 4: Decomposition of GDP per Worker Growth (y'), 1948-2011 (%)

	y'	TFP'	% of y'	(uk')	% of y'
1948-62	4.40	1.67	0.38	2.73	0.62
1963-67	2.40	0.50	0.23	1.80	0.77
1968-73	5.70	3.30	0.58	2.40	0.42
1974-80	3.60	0.90	0.26	2.70	0.74
1981-92	-0.80	-1.00	1.37	0.30	-0.37
1993-99	0.70	0.25	0.35	0.45	0.65
2000-11	1.20	1.00	0.81	0.20	0.19
1948-11	2.30	0.85	0.37	1.43	0.63
1948-80	4.16	1.63	0.39	2.52	0.61
1981-11	0.31	0.02	0.06	0.29	0.94

Source: see text

The numbers in Table 4 are revealing about the relative roles of capital deepening [(uk')] and technical progress (TFP') in the explanation of Brazil's economic growth collapse after 1980. Observe first that, for the period a whole, 1948-2011, the growth rate of GDP per worker was 2.3% per year. Capital deepening contributed with 63% for this performance and TFP' with 37%. An almost similar partition obtains for the period 1948-80, except for the fact that, in this case, GDP per worker gained 4.2% per year. In 1981-2011, the growth of GDP per worker sinks to only 0.3% per year. A sharp drop in capital deepening is the main ingredient for such poor performance: capital deepening falls from 2.5% per year before 1980 to 0.3% per year after 1980. Its contribution to the mediocre GDP per worker growth in the later period rises to 94%. This justifies our emphasis on capital accumulation as the main source of Brazil's growth collapse after 1980.

On the other hand, it is noteworthy that the rate of technical progress also sinks from 1.6% per year to nil from the period before to that after 1980. Moreover (in addition to the 1948-62 period, when Brazil as the rest of the world benefitted from the post-war economic boom), the phases with the highest rates of technical progress are 1968-73 and 2000-11, both of which benefitted from policy reforms introduced in the periods immediately preceding them.¹⁰ Finally, we find that "technical regression" was the dominant factor behind the long lost decade of 1981-92.

¹⁰ For an analysis of the role of the 1964-67 reforms on the 1968-73 "economic miracle" period, see Veloso, Villela and Giambiagi (2008).

6. CONCLUSIONS

The first finding in this paper was that there is a strong association between the GDP growth rate and the capital stock growth rate in the post-WW-II period. The usual Granger-causality tests suggest that capital growth causes GDP growth even more strongly than GDP growth causes capital growth. The second link has to do with the accelerator. The first one is consistent with the predictions of a Solow model outside the steady state.

We proceeded with an accounting-based analysis of the sources of growth both for the capital stock and for GDP per worker. For this purpose, we divide the long period since 1947 until 2011 into seven subperiods, characterized by some similarity in parameter behavior and the conduct of economic policy. Our focus is the collapse of gross fixed capital formation after 1980, from which Brazil did not fully recover even after overcoming hyperinflation in 1994. For the so-called long lost decade of 1981-92, we observed that little guilt can be attributed to domestic savings. What happened was a collapse of foreign savings as a result of the 1980s debt crisis. Three additional factors behind the collapse of capital accumulation between 1974-80 and 1981-92 were a reduction in capacity utilization, a decline in capital productivity, and more importantly a sharp rise in the relative price of investment.

The capital growth rate continued to fall between the long 1981-92 lost decade and the short 1993-99 decade of reforms. Responsibility for this now fell on a reduction in domestic savings and, secondarily, on lower capital productivity. Finally, between the age of reforms and the 2000-11 new macroeconomic regime period there occurred a modest acceleration in capital formation, explained mainly by increases in the use of installed capacity and a higher productivity of capital.

The last step in our review involved an estimation of the roles of capital deepening and technical progress in the evolution of GDP per worker. We found that capital deepening was responsible for nearly 2/3 of GDP per worker growth over the whole post-WW-II period (with a similar figure applying in the pre-1980 period). The sharp decline in the growth rates of GDP per worker after 1980

was also found to be in large proportion the result of a collapse in capital accumulation. However, technical progress — probably induced by previous economic reforms — was an important explanation both for the 1968-73 ‘economic miracle’ and for the growth recovery of 2000-11. Moreover, the long lost decade of 1981-92 was mostly associated with a “technical regression” induced by the debt crisis and hyperinflation.

Despite a modest recent increase in the output-to-capital ratio, domestic savings are too low to allow for growth rates higher than the 4% recorded in the last few years. The corollary is that growth can be stifled if access to international financing drops, as it happened in 2002 and again in 2008. We conclude, without surprise, that Brazil’s recent slow growth is due to low rates of investment and domestic savings. If they do not increase, the country seems doomed to grow at the modest rates observed in recent years.

References

Bacha, E. (1992). “External debt, net transfers, and growth in developing countries”. *World Development*, v. 20, n. 8, Aug.: 1183–1192.

Bacha, E. and R. Bonelli. (2005). “Uma Interpretação das causas da desaceleração econômica do Brasil”, *Revista de Economia Política*, v. 25, n. 3 (99), July-Sept: 163–189.

Bacha, E. and R. Bonelli. (2012). “Crescimento Brasileiro Revisitado”, in Veloso, F. et al. (2012).

Bonelli, R. and E. Bacha. (2012). “Crescimento brasileiro revisitado”. Rio de Janeiro: *Texto para Discussão n. 22*. Rio de Janeiro: IEPE/CdG. Available at www.iepecdg.com.br and www.portalibre.fgv.br, Centro de Economia Aplicada.

Considera, C. and S. Pessoa. (2012). “A distribuição funcional da renda no Brasil”. *Texto para Discussão IBRE*, May. Available in the site www.portalibre.fgv.br.

Veloso, F.; P. C. Ferreira; S. Pessoa; F. Giambiagi (eds). (2012, forthcoming). *Desenvolvimento Econômico: Uma Perspectiva Brasileira*. Editora Campus/Elsevier.

Veloso F.; A. Villela; F. Giambiagi. (2008). “Determinantes do “milagre” econômico brasileiro (1968-1973): uma análise empírica”. *Revista Brasileira de Economia*, v. 62, n. 2, Apr./June