



Universidade de Brasília
Departamento de Economia

Série Textos para Discussão

**Investment and Capital Accumulation in Brazil
from 1970 to 2000: a Neoclassical View**

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Texto nº 285
Brasília, Abril de 2003

Department of Economics Working Paper 285
University of Brasilia, April 2003

UNIVERSIDADE DE BRASÍLIA
DEPARTAMENTO DE ECONOMIA

TEXTO PARA DISCUSSÃO Nº 285

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Abstract

The present note aims to interpret the peculiar (increasing) behavior of the estimated capital stock series of the Brazilian economy for the period 1970-2000. The understanding of this capital stock dynamics is considered key in order to better understand the performance of the country's economy since the 1970s.

According to the neoclassical growth models, an increase in the investment output ratio should have a permanent positive effect on per capita aggregate output with a temporary impact on its rate of growth.

Our finding shows that once the policy oriented distortions is taken into consideration, the neoclassical theory is able to fairly describe the investment behavior, hence the Brazilian capital accumulation dynamics during the period under study.

1 Introduction

When studying the dynamics of the Brazilian main macroeconomic variables, one can identify a peculiar behavior present in the capital stock series. Contrary to the theoretically expected path, the capital output ratio series presents a steadily increasing trajectory.

One possible cause could be related to the employed method to estimate the capital stock series. According to this argument, the cost of an investment is not reflecting the associated value of the capital stock being generated.¹ Hence, the derived capital stock series through the Perpetual Inventory Method can be inappropriate.

Furthermore, assuming that the above argument proceeds, the question of how investment decisions are effectively taken even though the associated cost is higher than the value of the generated capital stock² remains to be answer.

The understanding of this problem, namely the explanation of the Brazilian investment and capital stock behavior turns out to be crucial in order to better understand the country's economic performance from the 1970s.

The aim of this note is to describe the main characteristics of the observed Brazilian investment and capital stock dynamics along this period. It is necessary to stress that our intention is not to build any formal model that could endogenously generate their empirically observed behavior. However, we consider this study to be a necessary step toward this ultimate objective.

This study is organized as follows. Section 2 presents the composition of the Brazilian investment during the considered period according to two different dimensions. Sub-section 2.1 refers to the investment allocated into construction and into machinery and equipments, whereas Sub-section 2.2 considers it according to the public or private source. This differentiation allow us to better understand the behavior of the capital stock accumulation in the period, in particular the participation of the public sector in the investment share as well as the particular type of capital being accumulated in the economy. Section 3 in turn analyses the capital series derived from those investment decisions. Special remark will be given to the question of relative prices of investment goods. Since the capital series is estimated according to the Perpetual Inventory Method the distortion in relative prices can cause in fact an over-estimation of the capital stock available in the economy.

¹See Gomes, Bugarin and Ellery Jr. (2001) for more details.

²The value of the capital stock in this context is understood as the expected value of the commodities produced by this stock in the future.

2 Investment Composition

The capital stock in Brazil is not computed based on the firm's balance sheets. Hence, all available capital stock series depend, in some degree, on the investment series or, as it is officially available, on the gross capital stock formation. Hence, the path of the later is key in order to understand the behavior of the former.

Within this perspective, the present Section describes the behavior of the Brazilian investment series. Special emphasis is given to its composition, constructions and machineries and equipments, as well as its source, public and private. This differentiation is necessary to better evaluate theories that suggest that the peculiar Brazilian capital stock behavior is mostly due to the public sector investment decision in the country, which is not necessarily taken according to an inter-temporal optimal allocation of resources. On the other hand, the distinction of those investment decisions, between constructions and machineries and equipments, allow us to evaluate the hypothesis that suggests that the observed increase in capital stock is due mainly to the increased demand of constructions as a mean to protect the agents' real wealth against inflation.

A careful look at the Brazilian investment share³ indicates that this ratio increased significantly since the 1970s. Figure 1 shows the dynamic of this series during 1947-2000. The average investment share grew from 16.42%, from 1947 and 1969, to 21.87%, from 1970 to 2000, even regarding the recession period when, theoretically, investment should have decline more than proportionately to aggregate output.

Another fact shown in this Figure is that the maximum investment share took place in 1989, reaching 26.86%, when aggregate per capita output fell and inflation rate was very high. Excluding this year, a maximum investment-output share of 25.7% can be found in 1975.

According to the neoclassical, Solow-Cass-Koopmans' type, growth models, which uses an aggregate production function, an increase in the investment ratio should cause a permanent increase in aggregate per capita output, moreover, it should have a temporary effect on the GDP's growth rate. Thus, if this prediction were correct one should expect a high temporary growth rate at the beginning of the 1970s in the Brazilian economy, returning to its historical mean thereafter.

The first part of this prediction was in fact observed in the country. In fact, the beginning of the 1970s is referred to as the "Brazilian Economic Miracle" period. The average per capita GDP of 3.95% for 1947-1970 went up to 7.36% in 1971-1976. Nonetheless, this rate shrinks to an average of 0.92% in 1977-2000.⁴

³The investment share is taken as the ratio between gross capital formation and GDP, both in current values.

⁴Source of data: IPEA, Brazilian Ministry of Planning.

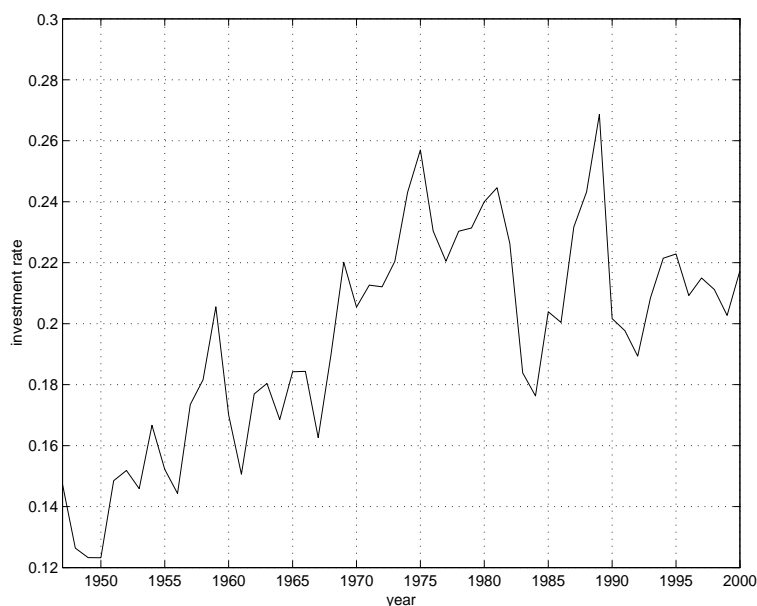


Figure 1: Investment Rate (Brazil 1947 - 2000)

2.1 Investment Allocation

The most important investment components in a long run analysis are constructions and machineries and equipments. This distinction is considered as a fruitful way to understand the investment behavior of the country, particularly the above observed change in the investment aggregate output ratio. Figure 2 below shows the allocation of the Brazilian investment during the period 1947-2000.⁵

As can be seen in Figure 3, the allocation of investment into constructions accounts in average for about 60% of the investment decision, whereas the acquisition of machineries and equipments represents about 32% in average. Moreover, we can see that along the 1970s the later was above its historical mean. In fact, during the 1970s constructions responded for 55.79% of investment and, machineries and equipments for 37.15%. Taking into account that this decade was characterized by high per capita GDP growth rates, it is not surprising to find an increase in the investment rate neither its allocation into machineries and equipments.

Furthermore, that increase in the investment rate can be clearly attributed to public policy oriented incentives.⁶ The postwar series of development plans pur-

⁵Values higher than one are generally associated with a negative inventory variation.

⁶See, for instance, the analysis of Lagos (1989 and 1990) and Resende (1990) on the Programa Estratégico de Desenvolvimento (PED/1967) of the Brazilian Ministry of Planning and the

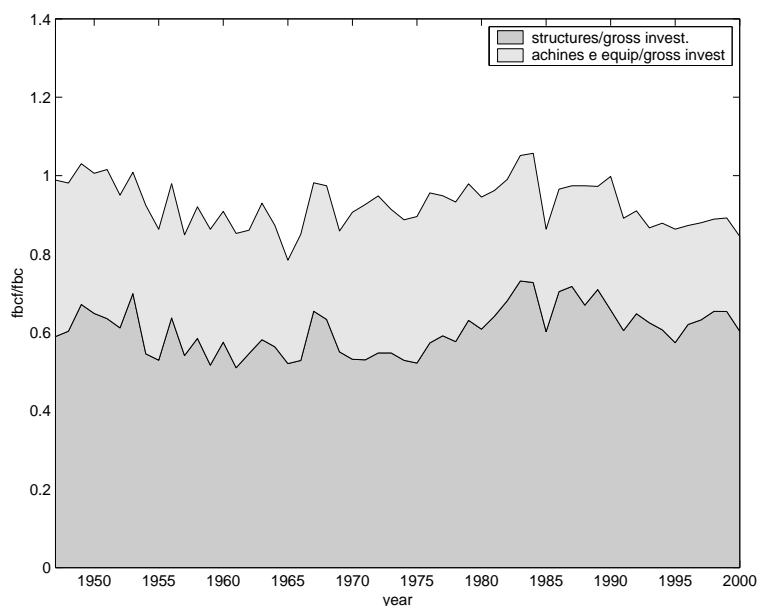


Figure 2: Investment Composition (Brazil 1947 - 2000)

sued in the country, what came to be called "desenvolvimentismo", is regarded by several authors as the main source of growth since 1968⁷. Its strongly pursued objective of high industrialization could have forced the Brazilian economy to use more capital intensive technologies, which could explain the effort in accumulating machineries and equipments in the early 1970s. Nevertheless, these arguments can not account for the high investment rates observed in the 1980s.

Figures 3a and b show the share of investment allocated into construction and into machineries and equipments respectively from 1970 to 2000. Figure 3a shows that the investment effort allocated into constructions accounted for most of the (high) investment ratio of the 1980s. Figure 3b in turn shows that machineries and equipments' share dropped abruptly since the second half of the 1970s, without recovering up thereafter in the 1980s and 1990s. Effectively, between 1985 and 2000, disregarding 1990 which was an atypical year due to the Plano Collor, this investment share remains below its historical mean.

Figure 4 shows the same variables of Figure 3 taken as GDP shares. It is apparent in this Figure that the investment effort was allocated into machineries and equipments in the 1970s and into construction in the 1980s. In particular, Figure 4b clearly shows that the increase in the investment share observed in 1975 was

Programa de Ação Econômica do Governo (PAEG/1967).

⁷See for instance Baer, W. (1995), chapters 4, 5 and 6, Versiani, F. and Barros, J.M. (1977) among others.

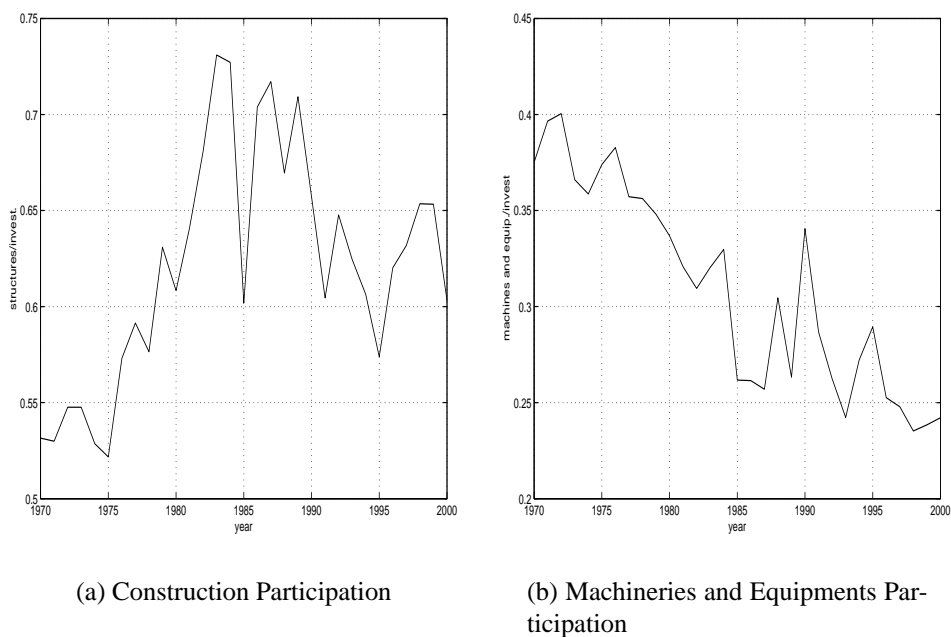


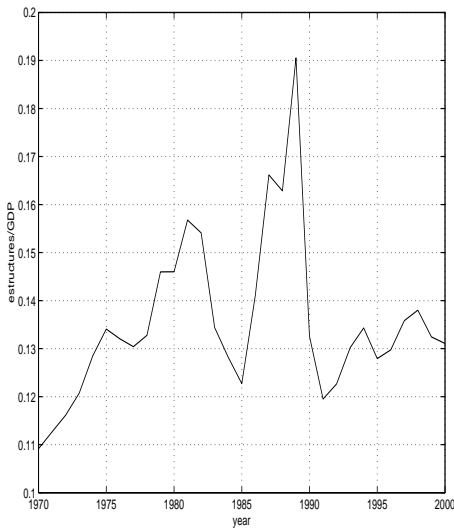
Figure 3: Investment Composition (Brazil 1970 - 2000)

due to the acquisition of machineries and equipments. Figure 4a in turn reveals the strong participation of constructions in the 1980s.

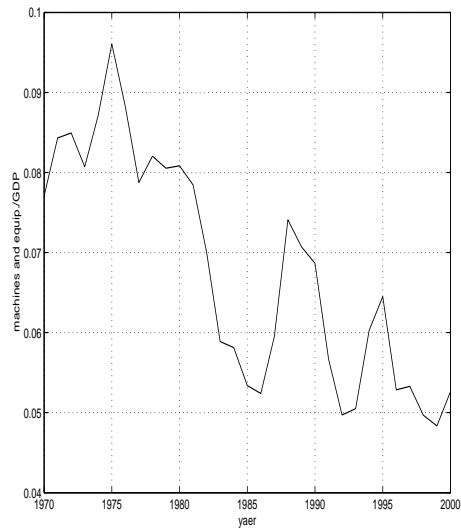
Moreover, while former experience of the 1970s was a result of public policies oriented toward a strong industrialization objective, the later experience of the 1980s can be seen as a result of the reaction of economic agents against fiscal and monetary policy imbalances. Due to the high inflation of this period and a high volatility of the financial market, the agents seek means to protect their real wealth by means of demanding real assets. On the other side, as suggested by Bacha (1993), stabilization policies based on price controls in a context of high inflation expectations, leads to a compensatory increase in long run price contracts, as it is the case of construction items. In turn, this behavior increases the relative (nominal) participation of constructions into GDP.

Figure 5 illustrates the relative prices of constructions and machineries and equipments.⁸ It is important to remark that constructions became relatively more expensive while machineries and equipments became cheaper. Nonetheless, this analysis which considers variations in nominal prices could not reflect necessarily

⁸The relative price of construction was calculated as the ratio of IPA-DI index for construction items and the general price index IPA-GI. For the relative price of machineries and equipments, the ratio between the index IPA-DI for machineries, vehicles and equipments and the general index IPA-GI was computed. Source: IBGE/BR.



(a) Construction Participation



(b) Machineries and Equipments Participation

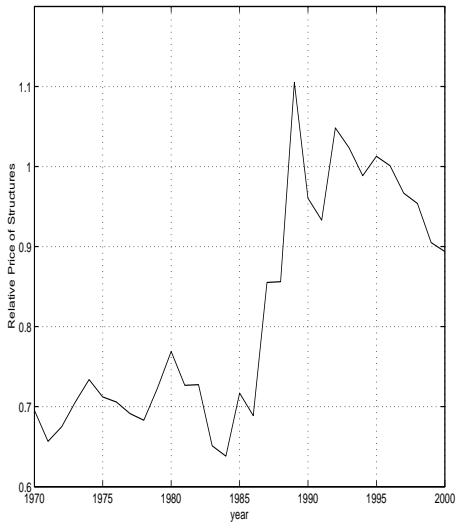
Figure 4: Investment Components as GDP Shares (Brazil 1970 - 2000)

changes in their respective quantities. Hence, in order to describe the associated quantitative changes it is necessary to adjust the investment share in GDP and the corresponding shares of both components by its appropriate price indexes, such that they can be taken at constant prices.

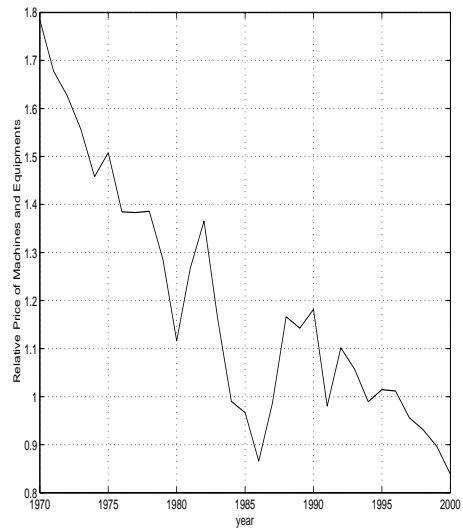
The investment share in aggregate output measures the cost of investment in terms of current consumption which the society is giving up in order to achieve more future production. Hence, it is important to have a quantitative idea of the given investment decision in order to determine that associated production capacity increase. Consider a barn as an example. The cost of this construction investment in the 1970s implied to give up a smaller quantity of durable consumption goods or machineries and equipments than in the 1980s due to the construction relative price increase. Moreover, since this cost increase is associated to nominal rather than productivity effects, it does not necessarily imply an increase in future production capacity.

Once the investment components are corrected by their respective price indexes, the fall in the real investment rate is apparent.⁹ As it is shown in Figure 6a, the real investment rate was higher in the 1970s than in the 1980s and 1990s.

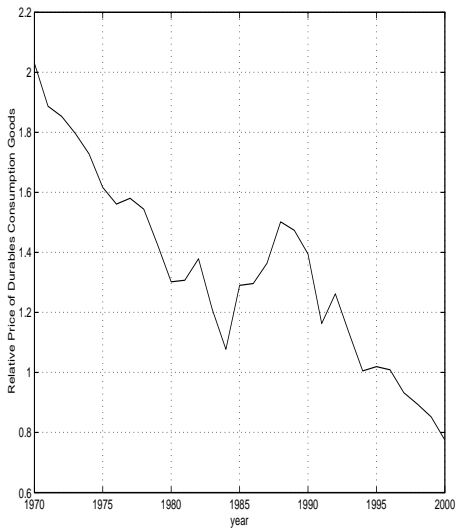
⁹The above referred IPA-DI and IPA-DI are taken as deflators for the investment components and the GDP deflator was used for aggregate output. The real investment rate is taken as the ratio between the sum of deflated investment components and deflated GDP.



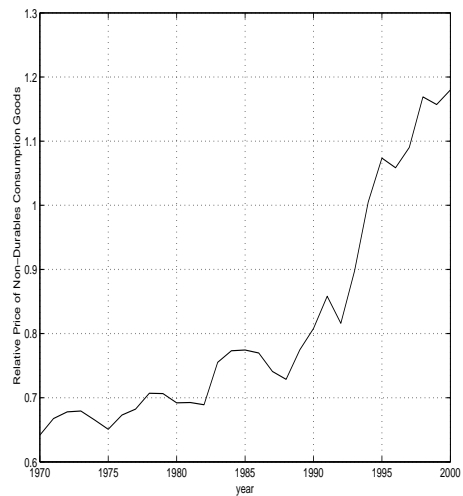
(a) Relative Price of Constructions



(b) Relative Price of Machineries and Equipments



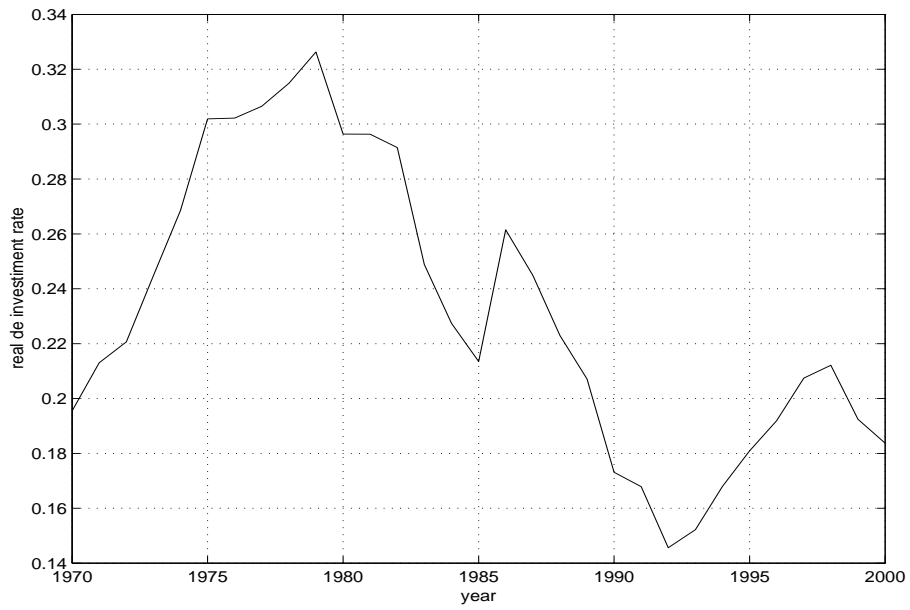
(c) Relative Price of Durable Consumption Goods



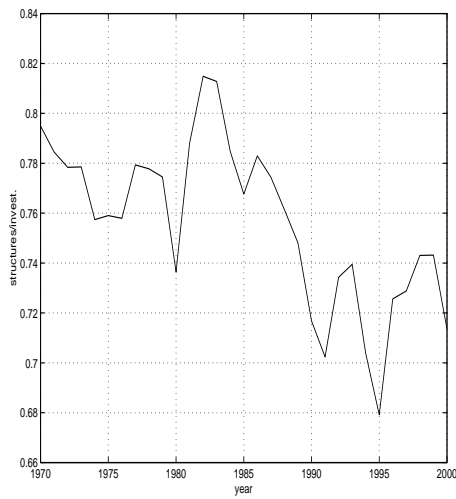
(d) Relative Price of Non-durable Consumption Goods

Figure 5: Relative Prices (Brazil 1970 - 2000)

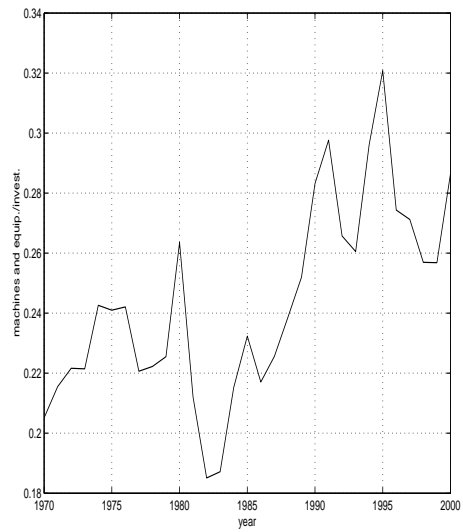
Moreover, after the 1982's external debt crises this share is not able to reach the 1970s' average level.



(a) Real Investment Rate



(b) Construction Participation



(c) Machineries and Equipments Participation

Figure 6: Real Investment Rate (Brazil 1970 - 2000)

Therefore, the neoclassical growth theory can account for the Brazilian experience of the 1970s, i.e. increase in investment rate associated with a temporary increase in the growth rate. Moreover, the high investment share observed specially during the second half of the 1980s was due to an increase in the relative price of investment goods, a nominal price phenomenon, in particular construction item prices. As it is shown in Figure 6 above, the real investment rate in fact decreases along this period and, as predicted by the neoclassical growth theory, the Brazilian economy showed a temporary growth rate decrease.

Figure 7 below presents both investment rates, with and without correction by relative prices, during 1970-2000. Without the adjustment, the investment share remains stable, so that it could not be able to support the accelerating growth path of the early 1970s neither the posterior observed stagnation of the Brazilian economy. With the appropriate relative price adjustments, on the other hand, the behavior of the real rate of investment can account for the growth performance of the considered period.

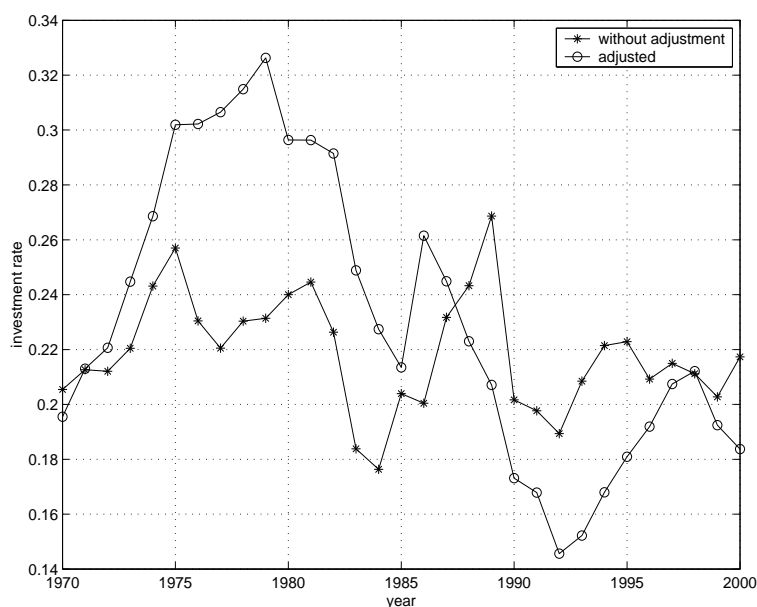


Figure 7: Investment Rates - Brazil

Based on the above presented arguments, we can conclude this Section pointing out that the neoclassical growth theory is compatible with the economic performance of the country during 1970-2000. The so-called "Brazilian Miracle" of the 1970s and the following depression of the 1980s and 1990s are the expected results of long-run real variables changes, in particular real investment rates. Those

changes were result of the implemented public policies during the period pursuing to increase the investment rate of the economy, transforming the productive structure into a more capital intensive one.

Initially, the increase in the investment rate leads to a period of high growth, but when the economy fails to keep up that high rate, it brought in turn a new adjustment period. Consequently, the economy had to naturally turn down to its previous low per capita income level. But policies aiming to inhibit such an adjustment, by means perhaps of exploiting some trade-off between inflation and growth or of protectionist policies, are only able to widespread that natural adjustment period.

According to the neoclassical growth theory, the long-run growth is determined by the productivity growth. If this theory were able to be applied to the Brazilian experience, as it seems to be the case according to the above arguments, the country's sustainable growth could only be attained by means of policies which could induce an increase in its productivity.

Along this Sub-section it was argued how the Brazilian economic performance during 1970-2000 can be interpreted based on the neoclassical theory. The above argument implicitly assumed that the government can somehow alter the investment rate of the economy. The next Section is devoted to discuss how the Brazilian government interfered into the rate of investment, which does not necessarily correspond to an optimal inter-temporal allocation of resources.

2.2 Sources of Investment

The aim of this subsection is to evaluate how much of the investment effort comes from the public and the private sectors respectively. The evaluation of the public investment vis à vis the private one is crucial in order to understand the roll of the Brazilian public sector in its capital accumulation process. Furthermore, this understanding can give support to the argument which sustains that a considerable share of the country's investment rate had a much higher cost than the value of the capital being accumulated as suggested by Gomes, Bugarin and Ellery Jr (2001).

Figure 8 below shows the dynamics of the public as well as private investment along the period 1970-2000 without adjusting the public enterprise's investment as public investment. As depicted there, public investment appears to be stable and even with a mild decline in the long run.

Figure ?? in turn shows the behavior of the public sector participation in construction and machineries and equipments from 1970 to 2000. Along the considered period, public investment in construction averaged 19.03% of total construction, but one can observe a considerable variability along the interval. At the beginning of the 1970s this public share reaches 32.61%; from 1972 to 1983 drops from 27.14% to 12.17%, slowly recovering to 23.85% in 1992. But in

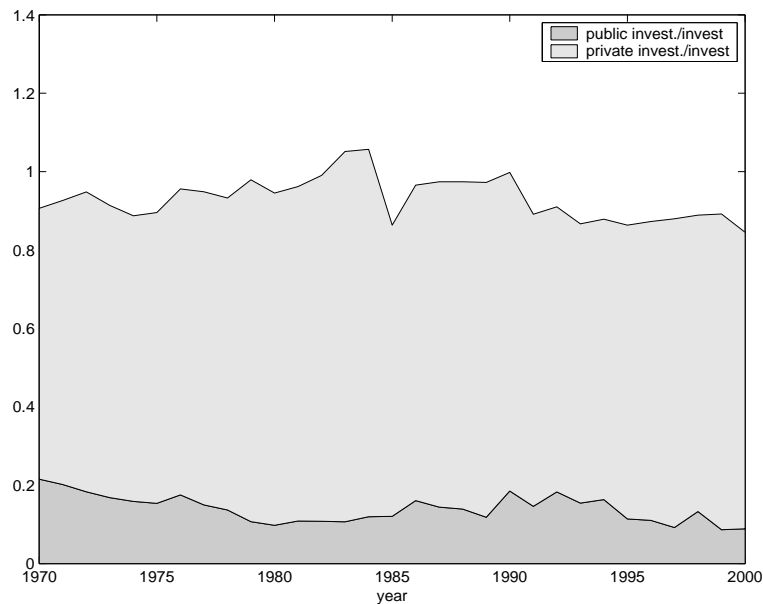


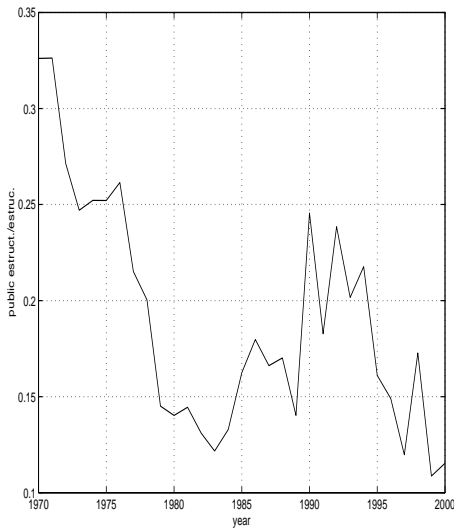
Figure 8: Source of Investment (Brazil 1970 - 2000)

2002 this share declines to 11.53%. This apparent instability can also be observed in the government effort to accumulate capital in the form of machineries and equipments. Its participation in total investment in machineries and equipments averages 7.84%, with a maximum of 13.06% in 1986 and a minimum of 3.06% in 1980.

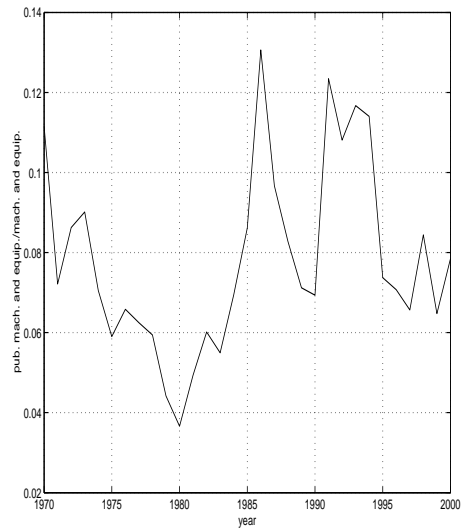
A careful reading of the data reveals that the investment of public enterprises is included into private investment. Thus, the description above does not give us useful information for understanding the participation of the government in the observed increase of the investment rate in the 1970s, neither the high real investment rates between 1975 and 1979. Since the investment of public enterprises is computed as private investment in the National Account statistics, we need to first arrange the data correspondingly in order to gain some insight about the government intervention into the investment decision undertaken in the period.

It is a noteworthy fact that the investment of public enterprises has been largely used for public policy purposes along the 1970s and also in the 1980s. In particular, these enterprises were used as a means to pursue a so-called "developmentist" policy.¹⁰ Figure 10 below shows the investment share of the Brazilian public enterprises during 1970-2000. Interestingly, from 1975 to 1980 when this

¹⁰See Paiva de Abreu, chapters 10 and 11.



(a) Government Participation in Construction Investment



(b) Government Participation in Machineries and Equipments Investment

Figure 9: Participation of Government in Investment

enterprises most contributed to total investment¹¹ corresponds to the period in which the real investment rate reached the maximum level.

Taking the investment of public enterprises and the public investment together it becomes apparent that the increase of total investment during 1975-1979 is due to public policies. Figure 11 below shows the behavior of this aggregate public investment as a share of total gross capital formation. Moreover, it can be seen that this share takes values considerably above average during the considered sub-period, exactly at the time when an increase in the real investment rate is observed.

Therefore, it is possible to conclude that there had been a temporary policy oriented increase of the investment rate in Brazil along the 1970s, which in turn increased the growth rate of the economy. But with its substantial decline in the 1980s the economy should have undergone, as it in fact did, through an adjustment process of its output. This expected recession is observed in the 1980s and 1990s. Thus, it is possible to assert that the Brazilian economy had have a performance compatible with the one predicted by the neoclassical model once the policy interventions are taken into account.

Moreover, an interesting point is to explain why the investment rate of the 1980s and 1990s remained below the level observed before the 1970s. One possi-

¹¹This contribution reaches 33.53% of total investment in 1978

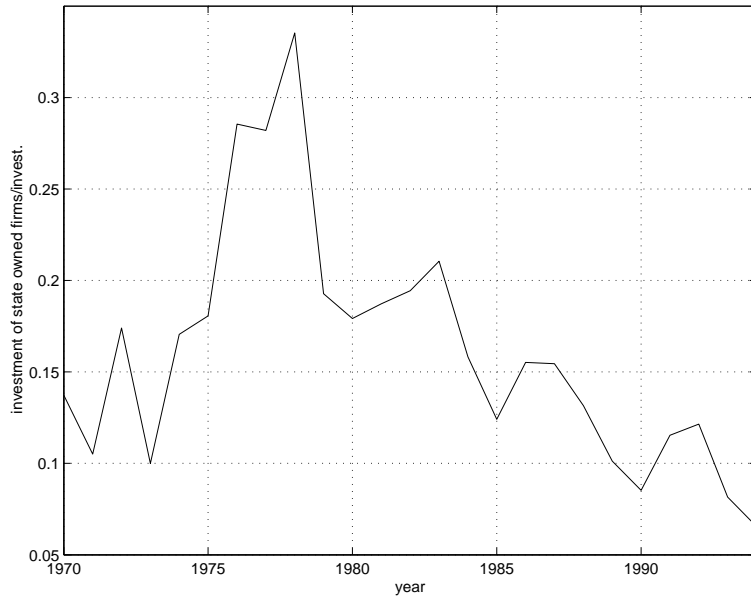


Figure 10: Public Enterprises Participation in Gross Capital Formation (Brazil 1970 - 1994)

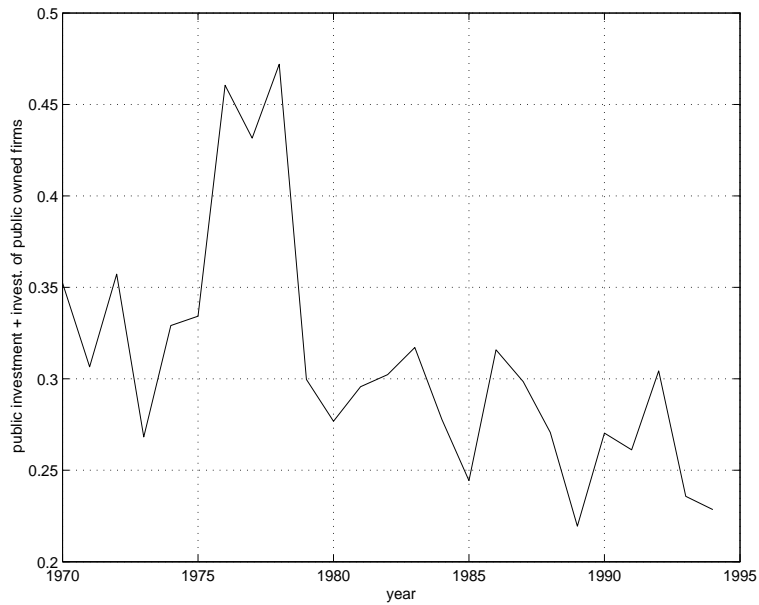


Figure 11: Public Investment and Public Enterprises's Investment (Brazil 1970 - 1994)

ble explanation could be based on the "developmentist" policy which could have anticipated the investment otherwise undertaken afterwards. In order to gain some more insight along this line of argument the next subsection presents the composition of capital derived from the above investment decisions.

3 Capital Composition

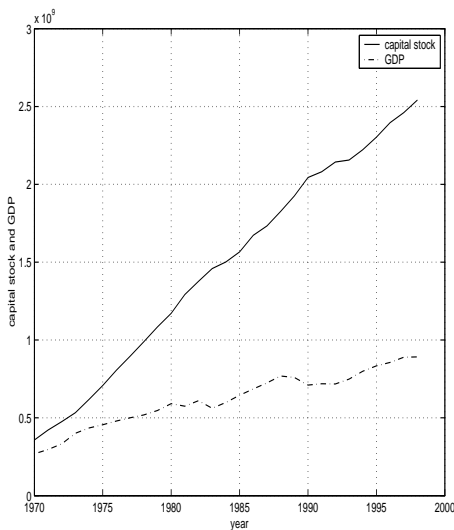
According to the argument above, the investment behavior from 1970 to 2000 was mostly determined by public policies, either through public direct investment, through public enterprises' investments or indirectly through the distortions introduced by the hyperinflation of the 1980s. Due to the lack of data on capital stock, it is impossible to develop an analysis similar to the one above for aggregate investment.

Morandi (1986) presents one of the few studies which try to construct a capital stock series for Brazil. This series will be herein used to study the capital stock dynamics of the country. However, it is important to notice that the Perpetual Inventory Method is used by the author, which equates the capital stock to the discounted sum of the depreciated investment flow. As pointed by Gomes, Bugarin and Ellery Jr (2001) this method is appropriate only when the cost of investment equals the expected discounted value of income generated by the capital stock under consideration.

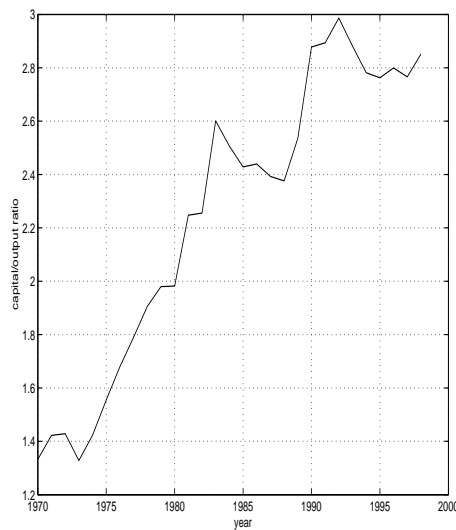
Figure 12a shows the capital series which rapidly increases from 1970. This growth of capital stock contributed to increase in turn the capital output ratio along the 1970s and 1980s as depicted in Figure 12b. As seen in the previous subsection, the nature of the undertaken investment was different between these two decades. Investment in the 1970s responded to explicit policies towards the so-called development objectives, whereas in the 1980s the strong relative price distortion generated an over-estimation of the economy's gross capital formation. The question of how these different sources of investment can account for the observed increase in the capital stock series along each decade will be explored in this section.

During the 1970s the capital stock increased at an average rate of 11.48% whereas the aggregate product measured by the GNP increased annually at 7.56% in average. Hence, the capital output ratio increased annually at 4% in average. On the other hand, in the 1980s the former increased at 4.72% and the GNP at 2.29%, hence the capital output ratio increased approximately at 2.5%. Thereafter, from 1991 to 1998, the Brazilian GNP increased at an average rate of 2.75% a little higher rate than the 2.54% growth rate of capital stock. Then, it is possible to assess the stability of the capital output ratio along this last sub-period.

Figure 13 below depicts the capital output ratio behavior in each of the above three considered sub-periods.



(a) Capital Stock and Output



(b) Capital/Output Ratio

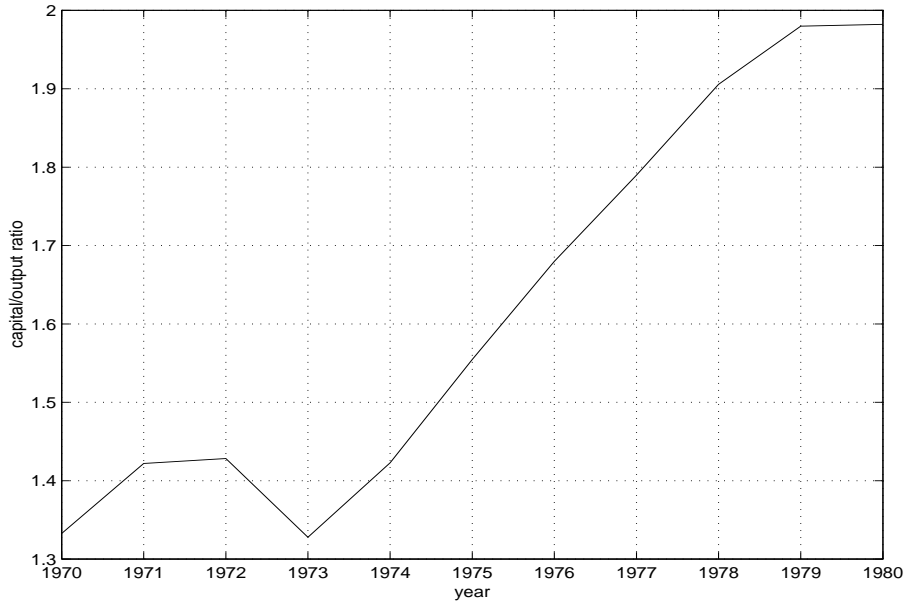
Figure 12: Behavior of Aggregate Capital and Output (Brazil 1970 - 1998)

>From Figures 13b and 13c it is possible to observe that the increase of the capital output ratio in the 1980s occurred simultaneously to the increase of the relative price of construction materials. At the end of the turbulent political period which characterized the beginning of the 1990s, the capital-output ratio settles approximately to 2.75 - 2.85.¹²

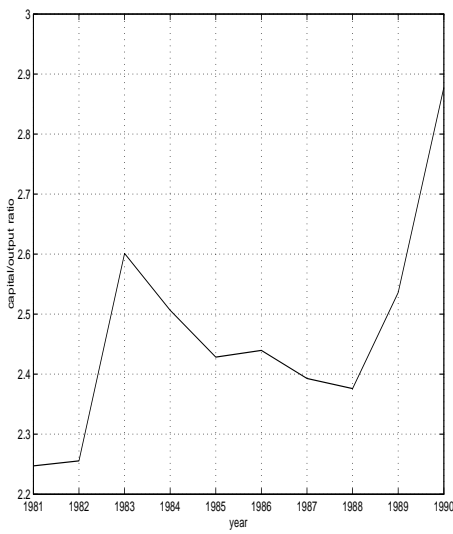
Next, a careful consideration of the capital-output ratio along the 1970s, in particular from 1973 to 1979 - the period between the two oil shocks-, remains to be developed. Figure 6 above showed that between the two oil shocks there was an increase in the quantum of investment. The presented argument related this increase to the so-called "developmentist" policies pursued by the government. Therefore, it is possible to infer that the increase in the capital-output ratio from 1973 to 1979 is clearly related to the implemented economic policies. Nevertheless, those developmentist and import substitution policies were present in the Brazilian economy since (at least) the end of WWII. For instance, long run policies explicit in the Plano de Ação Estratégica do Governo (PAEG) and the Plano Nacional de Desenvolvimento (PND) did not present any drastic change compared to previous long run policy orientations¹³. Thus, it is still necessary to understand the change of the Brazilian government orientation in 1973. One

¹²The 1998's increase of the capital-output ratio can be attributed to the effects of the exchange rate crises over the GNP.

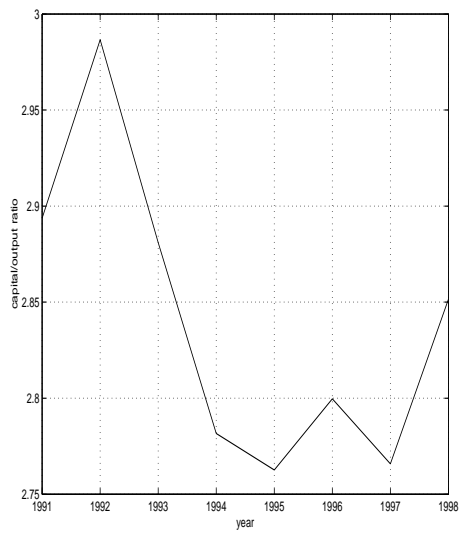
¹³See Paiva de Abreu (1990).



(a) Capital/Output Ratio, 1970 - 1980



(b) Capital/Output Ratio, 1981 - 1990



(c) Capital/Output Ratio, 1991 - 1998

Figure 13: Capital/Output Ratio

immediate answer could be to consider the exogenous oil shock as a determine factor.

In a series of studies Martins (1977 and 1979) argues that the Brazilian government's answer to the oil shock was based on a forced increase of the saving rate in order to sufficiently accumulate capital stock, in such a way to compensate the reduction of real income due to the drop in productivity caused by the shock. The author's arguments can explain the observed facts of Figure 6, once the pursued increase of the saving rate could not be sustained permanently¹⁴.

This pursued strategy of maintaining the economy in a high level of growth despite the decrease in productivity caused by the oil shock, constitutes a main characteristic of the Brazilian economic policy up to the beginning of the 1980s. The second oil shock and the external debt crises in the beginning of the 1980s make evident the end of this political strategy, leading the economy into the Brazilian depression as described by Bugarin et al (2002).

The behavior of total factor productivity (TFP) is depicted in Figure 14 below. According to this figure, TFP dropped approximately 7.5% in 1974, even though per capita aggregate product keeps increasing. Therefore, the suggested argument of the adjustment to the oil shock through an artificial and forced increase of the saving rate to compensate the drop of productivity by capital accumulation can be clearly sustained.

An interesting additional question is why this continuous capital accumulation process up to the beginning of the 1980s did not, in fact,

increase the productivity of the Brazilian economy. But since this process is related to a forced and artificial capital accumulation, investment projects with a low return feasible with the implemented policies of the 1970s turn out to be unfeasible with the end of this economic policy strategy. Moreover, as suggested by Parente and Prescott (2000) the implementation of a low productive project can generate interest groups to politically keep an otherwise unfeasible project. This line of argument appears to be consistent with the Brazilian experience: in fact the country turns back to be closed in the 1980s.

In other words, the required adjustment consistent with the productivity decline in 1974 is postponed for the 1980s. The compensating capital accumulation of the 1970s was strongly induced by public policies, which in turn made feasible low productive projects. Those low productive project then implemented could be affecting the current Brazilian productivity due to the inter-temporal policy induced distortions in the allocation of investment resources.

This section showed that the dynamics of the capital stock series and the capital-output ratio could be explained through the neoclassical theory once the distortions of the implemented economic policies are taken into consideration. An

¹⁴Martins in 1977 already pointed out the impossibility of increasing the prevailing high saving rate of 20%. The author clearly states the infeasibility of the pursued strategy of compensating the decline of the country's productivity by means of a forced and permanent increase of domestic capital accumulation.



Figure 14: Total Factor Productivity (Brazil 1970 - 1998)

estimate of the magnitude of the inefficiency caused by the underlying adjustment policy for facing the oil shock can be found in Gomes, Bugarin and Ellery Jr. (2001).

4 Conclusion

The aim of this note is to analyze the behavior of the Brazilian investment and capital stock series for the period 1970-2000 through the lens of the neoclassical theory. Once the distortions introduced by the implemented economic policies were taken into consideration, this theory gives a fair interpretation of the dynamics of investment and, consequently of capital stock as well as capital output ratio series.

The high real investment rate observed in the country in the 1970s induced a temporary increase in per capita aggregate output. Hence, the so-called "Brazilian Economic Miracle" could be understood as an expected result according to the neoclassical theory. It was shown that this high investment rate was policy driven. The policy strategy of forced capital accumulation in order to compensate the decline in productivity brought about by the oil shock increased the capital intensity in the country's productive structure.

Nevertheless, the permanent increase in productivity, natural theoretical out-

come of a capital accumulation process, is not observed in the Brazilian economy afterwards. Once the artificial capital accumulation effort made possible the realization of low return investment projects which otherwise would be unfeasible, this strategy compromised the sustainability of the pursued high economic growth rate.

Furthermore, the required adjustment to face the productivity decline of the early 1970s is postponed for the 1980s. The resulting inter-temporal distortion due to this transfer of the required adjustment is apparent in the difficulties the Brazilian economy faces to catch up its sustainable growth path, which could be understood as the opportunity cost of the Brazilian Economic Miracle.

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