EMPIRICAL ANALYSIS OF DEVELOPMENT
FINANCING IN BRAZIL: 1960-2008

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Área Temática 4: Desenvolvimento Econômico.

Resumo: No processo de desenvolvimento do Brasil, ocorrido no período de 1960 a 2008, a poupança interna foi relevante para o financiamento da formação de capital fixo do que a poupança externa. Esta conclusão foi obtida por meio de dois modelos aplicados de três hiatos. O primeiro é um modelo VAR e o outro, um modelo de regressão não-linear. Neste sentido, a implementação de decisões de política econômica de longo prazo que elevem o nível da poupança interna brasileira tendem a ser um tópico importante na agenda brasileira de desenvolvimento nesta década.

Palavras-chave: financiamento do desenvolvimento, modelo de três hiatos, modelo auto-regressivo vetorial (VAR), causalidade de Granger.


Abstract: In the financing of development of Brazil, in the period 1960–2008, domestic savings played a more important role than foreign savings. This conclusion was reached by means of two applied three-gap models. The first one is a vector autoregressive model (VAR) and the other is a non-linear regression model. In that sense, implementing long-term economic policy decisions that improve the level of domestic savings in Brazil tend to be a strategic topic in Brazil’s development agenda for this decade.

Keywords: financing of development, three-gap model, vector autoregressive model (VAR), Granger causality.

JEL Classification: O11, O16, O21.

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Empirical analysis of development financing in Brazil: 1960-2008

1. INTRODUCTION

This paper analyzes the process of development financing in the Brazilian economy in the period 1960–2008.

A three-gap model and the standard vector autoregressive approach (VAR) are used. Under the VAR approach, all variables are endogenous. The focus of the interpretation of the model’s results is on investigating the impulse response functions of an innovation in the series of these variables.

After analyzing the results of the two models, brief economic policy considerations are made, which are followed by final considerations.

2. ON GAP MODELS

The first discussions on the need of external aid for economic growth took place in the 40s and 50s, after the Second World War and the reconstruction of Europe. At the end of the 40s, the perception about the existence of constraints to economic growth of a nation became widespread among North American, European, and Latin American economists. American economist Hollis Chenery argued that these constraints stemmed from the scarcity of dollars.

Latin American economists, most of whom working for the United Nations Economic Commission for Latin America and the Caribbean (ECLAC), believed that such constraints occurred because of ‘external strangulation’ in developing countries. The main scholar defending this approach was Argentine economist Raul Prebisch.

The two-gap model was developed initially by Chenery (1950) and formalized by Chenery and Bruno (1962). Conceived to analyze constraints to economic growth in developing countries, especially in the case of Israel in its first years, the model was based on the theoretical conclusions of the Harrod-Domar model. Gap models are currently used to analyze the processes of financing development of open economies, whether in developing or in developed countries, as well as to investigate the long-term effects of economic policies. With respect to developing country economies, many papers using gap models maintain that developing countries face two long-term constraints to investment financing: the insufficiency of foreign exchange reserves (foreign exchange gap, or inability to obtain foreign savings) and the shortage of public and private savings (low domestic savings baseline).

The two-gap model is essentially a growth model based on the notion of accelerator under Harrod-Domar, starting from the classic view of foreign financing as a mere addition to domestic savings, understood as necessarily insufficient, the normative consequences stemming from the classic conception of growth strangling because of insufficient domestic savings are clear: i) increase in the propensity to save, via income concentration or the potentiation of a capital market; ii) increase in the

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3 According to Simonsen (1995, p. 490), the Harrod-Domar model is an adaptation of the contributions by Roy Harrod (1939) and Evsey Domar (1946) to economic growth theory. It was formalized in a closed economy, but, although both authors developed their work independently, the model was so named due to the similarities in the results obtained in the analysis of growth rate determinants.
output-capital ratio. In synthesis, the two-gap model adopts a Keynesian hypothesis of fixed prices, considering a growth model for a semi-industrialized economy with one sector, in which imported goods do not compete with intermediary and capital goods, and in which the exported product is the same that is consumed internally. An additional hypothesis is that the balance of payments of this economy includes only the balance of trade and capital transfers or foreign aid. These hypotheses were criticized by economists defending the neoclassical theory of economic growth. Such criticisms became increasingly dense as the process of commercial and financial liberalization of industrialized countries took place, as global exports increased, and as the complexity of capital movements and flows of goods became more intense.

Given the above, Bacha (1989) proposed a reevaluation of the two-gap model, stressing its importance in interpreting the macroeconomic conditions of developing countries in the 80s, which, in his view, was more significant than that of the neoclassical growth models. To that end, in 1989 he created the three-gap model, which is considered an extension of Chenery and Bruno’s (1962) two-gap model. The three-gap model perfected the two-gap model, including in it the interaction between (private and public) domestic savings and foreign savings in determining the economic growth rate of developing countries. Bacha described the importance of the fiscal constraints faced by a group of highly indebted countries with difficulty in carrying out public investments in infrastructure and basic industry, and created a model adding fiscal constraint as the third gap. Before this contribution, the two-gap models analyzed only the interaction between domestic and foreign savings, without further disaggregating domestic savings.

To deduce the three-gap model, Bacha started from a basic aggregate demand equation, rearranged for:

\[ I = (Y_d - C) + (M - X) \]  

Where: \( Y_d \) is the GDP or gross disposable income; \( I \) is the aggregate investment or the gross fixed capital formation; \( C \) is the sum of private consumption and government consumption; \( M \), imports of goods and non-factor services; \( X \), exports of goods and non-factor services.

From the accounts in the balance of payments, we deduce that:

\[ M - X = F - J \]  

That is, when imports are larger than exports, this deficit in the balance of trade will be covered by the difference between net capital inflows (\( F \)) and net foreign factor income (\( J \)).

Substituting (2) in (1), we have:

\[ I = (Y - C) + (F - J) \]  

In terms of the two-gap model, IS is represented by:

\[ IS = (Y' - C) + (F - J) \]  

The first term in parentheses in equation (2.2.4) can be called domestic savings. The second term is called foreign transfers. Therefore, when income is at its potential limit, \( Y' \), and private consumption is determined exogenously, equation (4) yields the level of investment restricted by domestic savings (domestic savings gap).

Putting \( J \) in the first parentheses:

\[ IS = (Y' - J - C) + F \]  

The previous simplification in (5) shows that the term in parentheses is national savings, and \( F \), foreign savings. This occurs assuming that the fluctuations due to capital outflows (variations in \( J \) in the short term) are not controlled by the government of the (net) capital recipient country. These variations are not subject to the decision-making process of this country. Therefore, foreign transfers (\( F-J \)) is a variable that is outside of the control of the country’s authorities.

\[ ^4 \] According to Bacha (1989, p. 215), it is admitted that the accumulation of foreign reserves is deducted from the capital account of the balance of payments. This is done in order to estimate the net value of capital inflows.
Moving on to the deduction of private savings, national income must be divided into government income (T) and private income (Y_P). Similarly, consumption is divided into private consumption (C_P) and government spending (G). Thus, based on (4):

\[ IS = S_p + (T - G) + (F - J) \]  \hspace{1cm} (6)

where \( S_p = Y_p - C_p \).

From which it can be concluded that:

\[ I = S_p + S^B + S^E \]  \hspace{1cm} (7)

When disposable income is at its potential limit, \( Y^*_d \), and private consumption is provided exogenously, maximum investment can be deduced. It is obtained considering the aggregate savings gap—called IS—and later the potential product growth rate (constrained by savings). In this sense, the abovementioned author considers a coeteris paribus situation in the incremental relationships between capital and product (which become constant).

To deduce foreign savings, he considered (2) as a starting point, divided imports in capital goods imports (M_K) and other imports (M_0), and defined net imports as the difference between other imports and total exports of goods and non-factor services (X). Thus:

\[ E = X - M_0 \]  \hspace{1cm} (8)

\( M_K \) is determined by the following function:

\[ M_K = ml \]  \hspace{1cm} (9)

\( m \) being the imported content of investments (\( 0 < m < 1 \)).

Articulating (8) and (9), inserting the resulting equation in (2), and rearranging the terms, it follows that:

\[ I = (1/m) \left[ E + (F - J) \right] \]  \hspace{1cm} (10)

Admitting the hypothesis that the level of net exports reaches at maximum a level corresponding to \( E^* \), and being this variable conditioned to the global demand, the maximum level of investment is limited by the supply of foreign reserves (IE). Such level is defined as follows:

\[ IE = (1/m) \left[ E^* + (F - J) \right] \]  \hspace{1cm} (11)

An important insight of the three-gap model refers to the fact that \( m < 1 \). Thus, comparing (6) with (11) leads to the same conclusion as Chenery and Bruno’s (1966; 1969): foreign transfers generate a more intense effect on growth rates of economies with foreign exchange constraints than on those with aggregate savings constraints.

To deduce the fiscal gap, Bacha started from the assumption that government investment in infrastructure and basic industry is fundamental in developing country economies. In this sense, he divided capital formation in two parts: government investment (I_G) and private investment (I_P):

\[ I = I_G + I_P \]  \hspace{1cm} (12)

Below, in equation (13), private investment is defined as a function of public investment, being \( k^* \) the coefficient that measures the crowding-in effect.\(^6\)

Inserting (12) in (6), the government budget constraint is obtained by:

\[ I_G = (S_p - I_p) + (T - G) + (F - J) \]  \hspace{1cm} (13)

It is admitted that private investment depends on government spending, such that its maximum value is given by:

\[ I_p = K^* I_G \]  \hspace{1cm} (14)

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\(^6\) This can be defined as the lack or the excess of savings in comparison with aggregate investment.

\(^*\) Effect that defines the impact of public investment on private investment.
Equation (14), according to Bacha (1989, p. 218), expresses the idea that the development of latecomer countries is characterized by a central role of the investment of their governments in infrastructure and basic industry, which establishes an upper limit for lucrative private investments.

Assuming that there is no long-term market for government bonds, monetary emission becomes the only alternative to finance public debt. Thus, the government can only capture the excess savings through seigniorage. Seigniorage occurs in function of two variables: i) inflation rate, $\pi$, and ii) marginal propensity to save, $h$. Thus:

$$S_p - I_p = dH / P = f(\pi, h)$$  \hspace{1cm} (15)

Substituting (15) in (13), and thereafter the result in (12), and also substituting (14) in (12), the level of investment under fiscal constraints ($IT$) can be expressed by:

$$IT = (I + K' \cdot [f(\pi, h) + (T - G) + (F - J)])$$  \hspace{1cm} (16)

With respect to the three-gap interaction, Bacha emphasizes:

As an introduction to the analysis of the interaction among the three gaps, it can be noted that that equations (2.2.14) and (2.2.15) can be read in different ways; in particular, for each inflation rate, equation (2.2.15) can only be consistent with (2.2.14) in case private savings is a slack variable, but under our hypothesis of a constant level of private consumption, this will not occur when the product is at its potential leve, that is, when the savings gap is operating. In this case, equation (2.2.15) will determine not the private savings, but the effective level of private investment, which will then be lower than $K' \cdot I_G$; that is, private investment, when the savings constraint is operating, is shifted from the financial market (BACHA, 1989. p. 219).

It should be highlighted that the fiscal constraint only applies when the inflation rate starts from some increasing threshold and reaches another threshold, generating a hyperinflation situation. In this case, additional increases in the inflation rate are associated with unemployment and with reduced rates of savings and investment.

3. VAR MODEL

The vector autoregressive model (VAR) was developed by Christopher Sims (1980) in his research work “Macroeconomics and Reality.” Starting from this paper, simultaneous equations models could be analyzed based on the interrelations among their component variables and the way they respond to ‘shocks’ that alter the intrinsic dynamics of these models. Therefore, VAR models allow to analyze the relative importance of each innovation, characterized as a “surprising event,” on their variables. A VAR system may or may not be structured. This section presents a non-structured VAR model, where relationships among the variables do not follow a formal theoretical rigor defined ex ante. In this sense, there is no prior definition, dictated by theory, of endogenous and exogenous variables. To the contrary, as the VAR methodology suggests, all variables are endogenous in the following model.

3.1. MODEL VARIABLES AND DATA SOURCES

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7 The propensity to save is introduced only to complement the framework, since it seems to vary substantially among countries and throughout time in some of them, being particularly high in Southeast Asia in the 90s decade.

8 Seigniorage, $(dH/P)$, is decomposed in inflation tax, $\pi(P/H)$ and in a real variation in liquidity, $d(H/P)$. When there is no real variation in liquidity, that is, $d(H/P) = 0$, the stationary state is reached. In this case, seigniorage and the inflation tax are identical.
The database used in the model considers a set of variables with annual periodicity between 1960 and 2008, as described below:

- The gross fixed capital formation (GFKF) series, in a percentage of GDP, has as its primary source the Brazilian Institute of Geography and Statistics (Instituto Brasileiro de Geografia e Estatística—IBGE) and as its secondary source the Brazilian Institute of Applied Economic Research (Instituto de Pesquisa Econômica Aplicada—IPEA).
- The foreign savings (S\text{EXT}) series, in a percentage of GDP, corresponds to the current account deficit in the balance of payments, and has as its primary source the Central Bank of Brazil.
- The government savings (S\text{PUB}) series, in a percentage of GDP, corresponds to the public sector’s need for financing. Therefore, it can be a deficit (negative savings) or surplus (savings) in government accounts.
- The private savings (S\text{PRIV}) series, in a percentage of GDP, was constructed by the authors based on the decomposition of total gross savings, the primary source of which is IBGE’s national accounts system. Private savings was calculated as gross savings minus public savings (S\text{PUB}) and foreign savings (S\text{EXT}).
- The real GDP growth rate (GDP) series, in annual percentage variation, corresponds to the variations in real GDP, deflated by the General Price Index—Domestic Availability (Índice Geral de Preços—Disponibilidade Interna—IPI-IPDI). The primary source is IPEA.
- The total investment rate series (I\text{INV}) has IPEA as its primary source.

### 3.2. ECONOMETRIC TESTS

The equation below, that serves as a starting point for the tests of... aims at supporting the interpretations of the results of the VAR model, which verifies how innovations in variables forming the tripod of the financing of Brazilian development affected gross fixed capital formation throughout the period 1960–2009.

\[
F_{\text{BFV}} = g(S_{\text{PRIV}}, S_{\text{EXT}}, S_{\text{PUB}})
\]  

(17)

The first procedure, before the application of the VAR model and the interpretation of the impulse response functions, is to carry out the unit root test. It allows to infer the statistics for the assessment of time series used in the research, and aims at verifying the behavior of each series as to mean, variance, covariance, and time-dependence.

With respect to time series stationarity, Hamilton (1994) emphasizes that a series is stationary if its properties do not vary in time. Thus, its mean and variance are constant in time, and the covariance between the lagged values of the series only depends on the lags of the series, that is, the time distance between them. With the goal of verifying the stationarity of the time series used in function of investment, in this section, and of the Granger-Newbold causality test, in the next section (3.4.3.1), the Augmented Dickey-Fuller (ADF) and the Philips-Perron (PP) tests were carried out. An intercept was used, as well as a null hypothesis that the variables are first-order integers, I(1).

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9 All the series for which the primary data source is IBGE were obtained from the secondary source on the IPEADATA website. All the series were calculated based on the New Methodology of the National Accounts System (Nova Metodologia do Sistema de Contas de Nacionais).
10 The notion of the unit root test stems from the concept of stationarity in time series. For more details, see, for example, Hamilton (1994).
11 The time series data of this regression are in Annex 2 of this paper.
12 Therefore, they have a unit root.
Table 3
Unit root tests – ADF and PP

<table>
<thead>
<tr>
<th>CRITERION</th>
<th>VARIABLES</th>
<th>IN LEVEL FORM</th>
<th>t-statistics</th>
<th>p-value</th>
<th>IN FIRST DIFFERENCES</th>
<th>t-statistics</th>
<th>p-value</th>
</tr>
</thead>
<tbody>
<tr>
<td>ADF</td>
<td>GFKF</td>
<td>2.6784</td>
<td>0.0555</td>
<td>-5.98905</td>
<td>0.0000</td>
<td></td>
<td></td>
</tr>
<tr>
<td>PP</td>
<td>GFKF</td>
<td>1.97257</td>
<td>0.02976</td>
<td>-5.99393</td>
<td>0.0000</td>
<td></td>
<td></td>
</tr>
<tr>
<td>ADF</td>
<td>S_PRIV</td>
<td>2.29358</td>
<td>0.0500</td>
<td>-6.65004</td>
<td>0.0000</td>
<td></td>
<td></td>
</tr>
<tr>
<td>PP</td>
<td>S_PRIV</td>
<td>2.295718</td>
<td>0.0483</td>
<td>-9.45029</td>
<td>0.0000</td>
<td></td>
<td></td>
</tr>
<tr>
<td>ADF</td>
<td>S_PUB</td>
<td>2.86745</td>
<td>0.0005</td>
<td>-6.97557</td>
<td>0.0000</td>
<td></td>
<td></td>
</tr>
<tr>
<td>PP</td>
<td>S_PUB</td>
<td>2.91357</td>
<td>0.0512</td>
<td>-8.64964</td>
<td>0.0000</td>
<td></td>
<td></td>
</tr>
<tr>
<td>ADF</td>
<td>S_EXT</td>
<td>2.460353</td>
<td>0.1314</td>
<td>-6.16783</td>
<td>0.0000</td>
<td></td>
<td></td>
</tr>
<tr>
<td>PP</td>
<td>S_EXT</td>
<td>2.460353</td>
<td>0.1314</td>
<td>-6.189450</td>
<td>0.0000</td>
<td></td>
<td></td>
</tr>
<tr>
<td>ADF</td>
<td>GDP</td>
<td>3.88175</td>
<td>0.0043</td>
<td>-10.5297</td>
<td>0.0000</td>
<td></td>
<td></td>
</tr>
<tr>
<td>PP</td>
<td>GDP</td>
<td>3.75035</td>
<td>0.0062</td>
<td>-12.9429</td>
<td>0.0000</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Source: Calculations by the author based on tests carried out in E-views 7.

The results in Table 3 allow to affirm, at a 90% confidence level, that the series GFKF, S_PRIV, S_PUB, and GDP are non-stationary in level. On the other hand, also at a 90% confidence level, the series S_EXT is stationary in level. Taking the first differential of each series, it is observed that all the series become stationary at a 99% confidence level, according to the ADF and PP tests. An analysis of the same table shows that some variables are non-stationary in level and are I(1).

In effect, a cointegration test was carried out—using the methodology developed by Johansen (1995)—to investigate long-term relationships among variables in the VAR system. If such relationships exist, they can be eliminated by a first-difference VAR model, allowing to investigate only the short-term relationships. According to Johansen (1995), one of the alternatives to capture the long-term relationships is to include in the VAR system an error correction term in the form of a cointegration vector (a VEC). However, such analysis is outside of the scope of this work, since one of its basic objectives is to verify how innovations in private, public, and foreign savings affect the trajectory of gross fixed capital formation, and this can be done through the analysis of the impulse response functions of the VAR model in level form.

Table 4
Johansen cointegration tests
(Number of cointegrating relations by model)

<table>
<thead>
<tr>
<th>Deterministic trends</th>
<th>None</th>
<th>None</th>
<th>Linear</th>
<th>Linear</th>
<th>Quadratic</th>
</tr>
</thead>
<tbody>
<tr>
<td>Data trend</td>
<td>No intercept or trend</td>
<td>Intercept without trend</td>
<td>Intercept without trend</td>
<td>Intercept without trend</td>
<td>Intercept without trend</td>
</tr>
<tr>
<td>Trace</td>
<td>2</td>
<td>2</td>
<td>2</td>
<td>1</td>
<td>2</td>
</tr>
<tr>
<td>Maximum</td>
<td>2</td>
<td>2</td>
<td>2</td>
<td>0</td>
<td>0</td>
</tr>
</tbody>
</table>

13 Significance level of 10%.
15 In VEC (vector error correction), the short-term dynamics of the variables in the system is influenced by the deviations from the equilibrium.
The result of the Johansen (1995) cointegration test, presented in Table 4, indicates that there is at least one vector of cointegrated variables in the long term. The test was performed with all the cointegrated series. They have the same order. To capture these long-term relationships, a standard VAR model was estimated with the variables in level form. Thus, estimations were made with stationary and non-stationary time series, and, based on those estimations, the degree of lag of the series was defined. It should be highlighted that, the higher the degree of lag, the lower the degrees of freedom. Thus, considering the number of observations in the sample, the choice of the number of lags adopted took into consideration the Akaike (AIC) and the Schwarz (SC) information criteria.

The most appropriate model, according to Table 5 below, was the one presenting the lowest AIC and SC values. After these tests were carried out, a one-lag model was selected.

<table>
<thead>
<tr>
<th>VAR lag order selection</th>
</tr>
</thead>
<tbody>
<tr>
<td>Model</td>
</tr>
<tr>
<td>GFKF (% of GDP)</td>
</tr>
</tbody>
</table>

Source: calculations by the authors in Eviews 7.

3.3. GRANGER-NEWBOLD CAUSALITY TEST

The causality test is based on the premise that there exists a causal precedence of a variable with respect to the other. Thus, it assumes that the relevant information to predict the variables are exclusively contained in the time series data of these variables. Or, mathematically, in accordance with the equation that follows:

\[
\begin{align*}
    y_t &= \left[ a_1, \ldots, a_p \right]^T y_{t-1} + \left[ \epsilon_t \right] \\
    y_{t-1} &= \left[ a_0 \right]^T a_{t-1} + \left[ \epsilon_{t-1} \right] 
\end{align*}
\] (18)

Here, the lagged variable \( y_{t-1} \) does not affect how \( y_t \) is determined. Therefore, \( y_{t-1} \) does not “Granger cause” \( y_t \). The matrix equation above represents a test based on the variance-covariance matrices of the residuals.

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16 Unstructured VAR model.
17 The Akaike information criterion is generally applied to series with small samples, differently from the likelihood ratio (LR) test, which is used for large samples.
18 The criterion is applied to small samples. The model with the lowest SC value is considered the most appropriate.
19 See table XX in the Annex.
Considering that one of the basic assumptions about the validity of the Granger causality test is that variables are stationary,\(^{20}\) in case they are non-stationary, they should be differentiated \(d\) times, until they become stationary. This is done because the test uses the null hypothesis that one variable “Granger causes” the other. In this sense, the generic representation of \(S\) (aggregate savings) and \(GDP\) are as follows:

\[
PJB = \sum_{i=1}^{n} a_i S_{t-i} + \sum_{j=1}^{d} \beta_j PIB_{t-j} + \alpha_t \tag{19}
\]

\[
S = \sum_{i=1}^{n} \lambda_i S_{t-i} + \sum_{j=1}^{d} \delta_j PIB_{t-j} + \alpha_t \tag{20}
\]

In addition, it is assumed that the \(\alpha_t\) residuals are not correlated.

Considering the \(p\)-values and the \(F\)-statistics in the table 7 below, the likelihood of obtaining \(F\)-statistics equal to or higher than those observed in the sample (assuming as true the null hypotheses of the first column of the table) demonstrates that the results of the application of the abovementioned test to the Brazilian economy confirm the occurrence of unidirectional causality in Granger’s sense between the following series:

i) \(S_{PUB}\) and \(GDP\), at a 99% confidence level;

ii) \(S_{PRIV}\) and \(GDP\), at a 99% confidence level;

iii) \(GFKF\) and \(GDP\), at a 90% confidence level.

Table 7
Causality test among savings, investment, and growth

<table>
<thead>
<tr>
<th>Hypothesis</th>
<th>(F)-statistics</th>
<th>(p)-value</th>
</tr>
</thead>
<tbody>
<tr>
<td>(DGFKF) does not Granger Cause (DGDP)</td>
<td>6.21304</td>
<td>0.00440</td>
</tr>
<tr>
<td>(DGDP) does not Granger Cause (DGFKF)</td>
<td>3.13795</td>
<td>0.05395</td>
</tr>
<tr>
<td>(DSPUB) does not Granger Cause (DGDP)</td>
<td>8.23917</td>
<td>0.00098</td>
</tr>
<tr>
<td>(DGDP) does not Granger Cause (DSPUB)</td>
<td>0.07407</td>
<td>0.92873</td>
</tr>
<tr>
<td>(DSPRIV) does not Granger Cause (DGDP)</td>
<td>10.1060</td>
<td>0.00027</td>
</tr>
<tr>
<td>(DGDP) does not Granger Cause (DSPRIV)</td>
<td>0.03029</td>
<td>0.97019</td>
</tr>
<tr>
<td>(DSEXT) does not Granger Cause (DGDP)</td>
<td>0.78391</td>
<td>0.46334</td>
</tr>
<tr>
<td>(DGDP) does not Granger Cause (DSEXT)</td>
<td>0.06854</td>
<td>0.93386</td>
</tr>
<tr>
<td>(DSPUB) does not Granger Cause (DGDP)</td>
<td>0.00754</td>
<td>0.99249</td>
</tr>
<tr>
<td>(DGFKF) does not Granger Cause (DSPUB)</td>
<td>0.25592</td>
<td>0.77543</td>
</tr>
<tr>
<td>(DSPRIV) does not Granger Cause (DGFKF)</td>
<td>0.04208</td>
<td>0.95883</td>
</tr>
<tr>
<td>(DGFKF) does not Granger Cause (DSPRIV)</td>
<td>0.14849</td>
<td>0.86247</td>
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<tr>
<td>(DSEXT) does not Granger Cause (DGFKF)</td>
<td>0.09432</td>
<td>0.91019</td>
</tr>
<tr>
<td>(DGFKF) does not Granger Cause (DSEXT)</td>
<td>0.58137</td>
<td>0.56368</td>
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N.B.: Rejecting the hypothesis that one variable (X) “Granger causes” the other (Y) means that X causes Y in Granger’s sense.

Furthermore, there is no causality in Granger’s sense between foreign savings and GDP at a 90% confidence level. The variables domestic savings (sum of $S_{\text{PUB}}$ and $S_{\text{PRIV}}$) and capital formation (GFKF) must be highlighted. The variables domestic savings ($S_{\text{PUB}}$ and $S_{\text{PRIV}}$) and GFKF “Granger cause” growth. During 49 years, in the Brazilian process of development, the importance of the sources of private and government capital ($S_{\text{PRIV}}$ and $S_{\text{PUB}}$) is noteworthy. However, it is not possible to say that the formation of savings preceded the formation of fixed capital. In the long-term capital accumulation in Brazil, public, private, and foreign savings did not “Grange cause” investment, although they were crucial for economic activity as a whole, since they had a significant effect on growth. Although there is a causal precedence relationship between (public and private) savings and growth, the same relationship does not exist among the three components of savings, on the one hand, and investment, on the other. In view of the above, the case of Brazil does not serve as empirical evidence of unidirectional causality between savings and investment (as put forth by neoclassical and new classical macroeconomists) or between investment and savings (as put forth by Keynesians). However, the case of Brazil serves as a stylized fact to characterize the importance of the formation of domestic savings for economic growth in Brazil in the period 1960–2008, and corroborates the theoretical Keynesian relationship between investment and economic activity. With respect to the unidirectional causality between (public and private) savings and GDP, the neoclassical theory indicates that, when the level of domestic savings increases, the lendable resources become more abundant, the interest rate is reduced, and the economic growth rate tends to increase, ceteris paribus. However, this assertion on short-term macroeconomic dynamics is outside of the scope of this paper, as gap models do not consider the interest rate as a determinant of long-term growth.

The empirical evidence of the Brazilian economic growth process cannot be explained by Solow’s (1956) model either, since, according to Simonsen, Solow’s model affirms that, “in the long term, the real product growth rate depends only on the workforce growth rate, and not on the savings rate.” (Simonsen, 1991, p. 5).

Finally, the unidirectional causality between GFKF and GDP corroborates the growth theory inspired in Keynes, as described by the Kaldor and Pasinetti models.

3.4. ANALYSIS OF THE IMPULSE RESPONSE FUNCTIONS

The impulse response function of a VAR model can be observed from equation (3.4.3.4) below. In this equation, a disturbance in $\mathbf{u}_t$ has an immediate and isolated effect on $y_{t,1}$, but does not affect $y_{t,2}$. In the period $t+1$, that disturbance in $y_{t,1}$ affects $y_{t+1,1}$, by means of the first equation, and also affects $y_{t+1,2}$, by means of the second equation. These effects are also applicable in $t+2$ and so forth. Thus, the disturbance of an innovation the VAR model irradiates a chain reaction throughout time in all variables in the VAR model. The impulse response function calculates these chain reactions.

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21 Hereafter referred to simply as “growth.”
22 This conclusion reinforces the analysis that the empirical literature on the long-term relationships among savings, investment, and growth is so controversial as to the role of savings and investment in the modern growth theory. For the theoretical literature on this subject, it is useful to see Domar (1957); Harrod (1948); Kaldor (1956); Pasinetti (1974); Samuelson and Modigliani (1966); Simonsen (1991); and Deaton (1994).
The analysis of impulse response functions (IRFs) presented in Figure 1 was carried out with all the endogenous variables in level form. Therefore, both the stationary and the non-stationary series were analyzed. The lighter dotted lines represent a confidence interval of two standard deviations (above and below), and the darker dotted line indicates the response of gross fixed capital formation to shocks equivalent to one standard deviation in private, public, and foreign savings.

Based on Figure 1, the shocks in these variables will now be analyzed. There are distinct effects on gross fixed capital formation.

Initially, when a shock occurred in foreign savings in the two first years (1960 and 1961), gross fixed capital formation responded negatively to the shock. Afterwards, in the period from 1962 to 1964, the response of gross fixed capital formation was positive, in a confidence interval between 0.5 and -1. In the period 1965–67, GFKF had a stable trajectory. Finally, it presented convergence from 1968 to 2008.

Still based on Figure 1 one can observe the shock in private savings and the response of gross fixed capital formation. In the period 1960–61, when a one standard deviation shock occurred in private savings, GFKF decreased. In the period 1962–65, GFKF responded positively to the shock. Starting from 1965, the series presented convergence.

With respect to a shock in public savings, a positive response is observed in gross fixed capital formation in 1960–61. In 1962–63, the trajectory of GFKF’s response to the shock was stable. From 1964 to 1966, this trajectory presents a decrease and, from 1967, it presents a convergence situation, in a confidence interval between 1.5 and -1.

\[
\begin{bmatrix}
  y_{1t} \\
  y_{2t}
\end{bmatrix} = \begin{bmatrix}
  a_{11} & \cdots & 0 \\
  a_{21} & \cdots & a_{22}
\end{bmatrix} \begin{bmatrix}
  y_{1t-1} \\
  y_{2t-1}
\end{bmatrix} + \begin{bmatrix}
  u_{1t} \\
  u_{2t}
\end{bmatrix}
\]

Figure 1
Impulse response functions of the VAR model
Response of FBKF to Cholesky
One S.D. SEXT Innovation

Response of FBKF to Cholesky
One S.D. SPRM Innovation

Response of FBKF to Cholesky
One S.D. SPUB Innovation
The table below summarizes the analysis of the IRFs. In this sense, it presents the qualitative response of the investment series to impulses of one standard deviation in each of the three variables.
### Table 8
Analysis of the impulse response functions

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Label:
- increase
- decrease
Three are the conclusions from the analysis of the IRFs:

i. Investment (GFKF) is more sensitive to impulses in public savings ($S_{PUB}$) than in private and foreign savings. This conclusion allows a series of considerations of economic policy measures aiming to increase public savings. These measures will be examined in the next section;

ii. In addition to investment being more sensitive to shocks in $S_{PUB}$, GFKF responds in a more durable way to these shocks;

iii. The sensitivity of investment to impulses in the foreign savings series is more durable and volatile than the impacts on the private and public savings series. This occurs because significant part of the current account deficit (foreign savings) is composed of short-term foreign capital and not of direct investment. Thus, the capital fluxes respond in a more aggressive way to adverse economic conditions than the variables that influence private savings and public savings.

5. FINAL CONSIDERATIONS

Through a three-gap model applied to the Brazilian economy, this paper sought to analyze the process of financing of development in the period 1960–2008.

The research procedure was based on the analysis of impulse response functions (IRFs), obtained through the vector autoregression econometric methodology (standard VAR model), and on the results of the Granger causality test. This test helped to investigate the causal precedence relationships among GDP growth rates, gross fixed capital formation, and the tripod of development financing. The analysis of the results of the VAR model indicated that the domestic sources of financing (public and private savings) were more important than the simultaneous generation of current account deficits (foreign savings).

Furthermore, the IRFs demonstrated that investment responded more to public savings impulses than to private and foreign savings impulses. Moreover, this response lasts longer than the responses of gross fixed capital formation to innovations in private and foreign savings. With respect to the response of investment to impulses in foreign savings, the analysis showed that they were more

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23 Which is equal to foreign savings, by definition.

24 Above all, portfolio investments, such as government bonds and stocks.

25 In acquisitions of national companies, creation of new companies, and privatizations, for example.

26 Such as the real interest rate, the profitability of corporations, inflation, the level of activity, taxation on financial assets etc.

27 Such as the real interest rate, the level of tax revenue, public expenditure, inflation, the level of activity etc.

28 The sources of long-term financing of development are private, public, and foreign savings, according to the three-gap model.

29 This finding is related to the fiscal and tax policies (and even to economic reforms) that—regardless of their success—aimed at promoting tougher fiscal discipline in Brazil. Among such policies are: the fiscal adjustment and the tax reform promoted by the Governmental Economic Action Plan (Plano de Ação Econômica do Governo—PAEG) in 1966, the constitution of emergency social funds in 1994 (a way to provide the country with minimum fiscal conditions for the adoption of the Referential Unit of Value (Unidade Referencial de Valor—URV), the fiscal adjustment of 1997 (known as “package 51”—Pacote 51), the enactment of the Fiscal Responsibility Law, the adoption of expressive fiscal surpluses suggested by the IMF, and the fiscal adjustment implemented in February 2011, at the beginning of the Dilma Rousseff administration.
durable and more volatile than those of private and public savings. The participation of the fluxes of short-term foreign capital in Brazil, mainly in the period 1972–1979 and after the Real Plan, contributed to the higher volatility of this response. These fluxes respond more aggressively to adverse economic conditions than the variables that influence private and public savings.

In what concerns the Granger causality test, it is possible to affirm at a 99% confidence level that private and public savings present unidirectional causation in relation to growth in Brazil in the analyzed period. The same can be said as to gross fixed capital formation, but at a 90% confidence level. However, there is no Granger causality between foreign savings and GDP. It is also not possible to affirm that the financing of development in Brazil occurred under the causal precedence of the formation of savings with respect to investment. Therefore, despite the importance of the formation of domestic savings, the process of financing Brazil’s growth cannot be considered as empirical evidence of the “prior savings hypothesis,” one of the cornerstones of the neoclassical savings and investment theory. However, the existence of unidirectional causality between private and public savings, on the one side, and growth, on the other, does not mean that the three sources of financing of development “Granger-caused” investment. Furthermore, there is no (unilateral or bilateral) causality relationship between investment and savings, as affirmed by the Keynesian theory of investment. On the other hand, the Keynesian long-term theoretical relationship between investment and economic activity was confirmed by the Granger-Newbold test. Keynes explains such relationship based on the formation of conventions. Thus, the results of the long-term inter-relations between investment and growth would arise from the degree of permanence of a positive state of confidence, which would depend on the formation of conventions in the short term.31

Finally, the econometric analysis presented here does not serve as a stylized fact of Solow’s (1956) model, since, according to Simonsen, Solow’s model asserts that, “in the long term, the real product growth rate depends only on the labor force growth rate and not on the savings rate” (Simonsen, 1991, p. 5).

REFERENCES


30 On this subject, the authors admit that the hypothesis of credit constraint formulated by Bacha may better explain this dynamics. However, the empirical test of a four-gap model incorporating such constraint is a difficult task, since in Brazil there is no long-term series that can serve as a proxy for credit constraint. The authors’ experience with regressions including a dummy variable to capture such constraint was not fruitful. However, it must be acknowledged that the noteworthy notion of credit constraint may eventually be useful as an auxiliary hypothesis in future research.

31 This theoretical explanation is plausible, but not empirically testable, given the impossibility, pointed out by Keynes himself, of measuring conventional behaviors and their resulting conventions.
17. MCKINNON, R. I. Foreign exchange constraints in economic development and efficient aid allocation. The Economic Journal.