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Article

The Determinants of the Long Term Private Investment in Brazil: An Empyrical Analysis Using Cross-section and a Monte Carlo Simulation

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ABSTRACT

Empirical studies regarding the determinants of private investment in developing countries, including Brazil, have demonstrated the high inflation's rates negative impact on investment. However, the recent Brazilian's experience clearly shows that stabilization is not capable of recovering investment's rates. Therefore, the objectives of this study are: a) to analyze the long term private investment's determinants in Brazil; b) analyze if the Brazilian economy has been impacted by the crowding-in or crowding-out effetcs; and c) analyze the macronomic variables' behavior during the 2012 to 2017 period. In order to do this, we used a cross section econometric analysis and a Monte Carlo Simulation for the data analysis. The paper presents the main investment theories, and recent developments of these theories, as well as how they can be applied to the Brazilian data. The results show evidences of a public investment crowding-in effect in infrastructure over the private investment. All the analyzed variables' signs are consistent with the theory, with the exception of the real interest's rates, where the coefficient is positive and insignificant in the estimated equation. The reduction in the credit's volume and the existence of political and economic instabilities showed that they are harmful to private investment in the analyzed period. The implementation of public policies in order to guarantee economic stability and improve the government's credibility, along with the increase of credit offer, could boost private investment in Brazil.

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Determinantes de la inversión privada a largo plazo en Brasil: análisis empírico utilizando secciones transversales y una simulación Montecarlo

RESUMEN

Los estudios empíricos dedicados a los determinantes de la inversión privada en los países en vías de desarrollo, incluido Brasil, han demostrado que la inflación elevada produce un efecto negativo en la inversión. Sin embargo, la experiencia reciente de Brasil muestra claramente que la estabilización no puede recuperar las tasas de inversión. Por lo tanto, los objetivos de este estudio son: a) analizar los determinantes de la inversión privada a largo plazo en Brasil; b) analizar si la economía brasileña se ha visto afectada por los efectos atracción o de exclusión; y c) analizar el comportamiento de las variables macroeconómicas en el período de 2012 a 2017. Para hacerlo, utilizamos un análisis econométrico transversal y una simulación de Montecarlo para analizar los datos. Este documento presenta las principales teorías de inversión y los desarrollos recientes de estas teorías, así como el modo en que pueden aplicarse a los datos de Brasil. Los resultados muestran la evidencia de un efecto de atracción de inversiones públicas en infraestructura por encima de la inversión privada. Todos los signos de variables analizados se corresponden con la teoría, excepto las tasas de interés real, en que el coeficiente es positivo e insignificante en la ecuación estimada. La reducción del volumen de crédito y la inestabilidad política y económica manifestaron que son dañinas para la inversión privada en el período analizado. La implementación de políticas públicas para garantizar la estabilidad económica y para mejorar la credibilidad del Gobierno, así como el aumento de la oferta de crédito, podrían incentivar la inversión privada en Brasil.

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1. Introduction

Empirical studies on private investment determinants in developing countries, including Brazil, show the high inflation rates' negative impacts, interest rates, exchange rates and international crisis of private investment. However, the recent Brazilian experience shows that stabilization by itself is not enough to recover the investment rate.

The investment in fixed capital can be considered a major component to determine the national product, the employment and income in a country´s economy, since it promotes the production activity's increase and expands the economic activity's level.

In Brazil during the last ten years, 89%, in average, of the gross fixed capital formation has been determined by the private sector, which accounts for approximately 15% of the Gross Domestic Product [GDP] during this period. The investment's pace and pattern in fixed capital are the central topics to be able to understand economic activity, and their volatility contributes greatly to aggregate fluctuations. From this perspective, theoretical models and empirical results stimulate investment and provide information for economic policy discussions.

Historically, the fixed capital gross formation with relation to the Brazilian GDP, measured with constant prices, decreased in average 23% in the 70's, 18.5% in the 80's and 15.2% during the 1990-1995 period (IPEA, 2012).

Empirical studies have been seeking to identify the private investment's determinants in Brazil. Some studies, such as Melo and Rodrigues Junior (1998) and Ribeiro and Teixeira (2001) among others, are the most frequently cited in the Brazilian literature. In order to specify an investment equation, these authors combine different theories –such as the accelerator model, the neoclassical model, the credit crunch effects, public investment and macroeconomic instability– and analyze the impact of these variables on the private investment level. The results suggest the aggregate demand's positive effects on investment, the negative relationship between private and public investment in the short term, the positive influence on credit availability and the economic instability's adverse impact on the private sector's investment in Brazil.

Thus, the objectives of this study are: a) to analyze the private investment's determinats in Brazil during the 1996 to 2011 period, using a cross section econometric analysis, in order to explain the fluctuations in the private investment; and b) to analyze the long term determinants' impacts on the private investment in Brazil, during the period of 2012 to 2017, using the Monte Carlo Simulation method.

This article differs, at least for three reasons, from existing work about the private investment's determinants in Brazil. First of all, the study uses a new database from the National Accounts' New System from the Brazilian Institute of Geography and Statistics; secondly, considering the number of observations and econometric data used characteristics, this study uses autoregressive distributed lag models (ARDL) to estimate the effects of the traditionally variables that are considered important for the private investment and; thirdly, the use of the Monte Carlo Simulation in order to analyze the long term macroeconomic variables' impacts on the private investment.

This study is divided into five sections: the first is the introduction; the following section describes the literature that are related to the investment determinants; third section presents the data and methods which describes the econometric model; section four presents the tests results and the econometric simulation during the period 1996-2011, and the Monte Carlo Simulation of the 2012-2017 period; lastly, the conclusions.

2. Literature review

Some of the first Brazilian empirical studies about private investment's determinants were developed in the 70's and 80's.

These studies contemplated the basic variables which, theoretically, could reflect the existing conditions of aggregated demand on the economy. The data used was about products, growth rates, private sector production and capacity utilization, among others. The results indicate that, in general, the aggregate demand appears to be an important variable with positive and significant coefficients, while capital cost was less relevant. An exception that could be made was the work of Reis, Cavalcanti, Castro, Rossi, Emerson, and Hernandes (1999), in which the interest rate was positive and statistically significant.

Dailami's (1987) study, one of the first to empirically investigate the investment's determinants in Brazil, used the annual gross domestic product variation, the capital cost's variation and the real wages, as also a measure of the economic instability as measured by the stock's volatility. The studied period comprised the years of 1958 to 1984 where the author found aggregate demand's positive effects and the changes in the real wages and the negative effects on the capital's cost and the economic instability on the private investment.

Studart (1992), Jacinto and Ribeiro (1998) and Ribeiro and Teixeira (2001) include financial variables such as credit availability in their empirical studies, where they found positive impacts in the various measures of investment. There is, however, the possibility of reverse causality, that is, the investment decisions have determined credit expansion (Rama, 1993).

The studies carried out by Studart (1992), Rocha and Teixeira (1996), Jacinto and Ribeiro (1998) and Cruz and Teixeira (1999), among others, studied the public investment's impact on the private sector´s gross fixed capital formation.

Ronci (1991), Melo and Rodrigues Junior (1998), and Santos and Pires (2007), included the public investment's measures in their aggregate models as a control variable. Some results indicate complementarity between public and private investment (Ribeiro & Teixeira, 2001) while others point to a displacement effect (Santos & Pires, 2007).

The vital role of the capital formation for a sustainable economic growth is widely recognized. However, in Brazil and in many other developing countries, investment rates had been declining up to the mid 90's, as a result, mainly, of the external debt crises and the lack of inflationary control.

The period of analysis in this study covers the macroeconomic impacts of the East Asian Crisis during the period of 1997 to 1998, the Russian Crisis in 1998, the Argentinean Crisis and the Brazilian Currency Devaluation, and the Global Financial Crisis, which started in 2008.

The results of other studies which have conducted empirical analysis of the private investment's determinants, as done here, are presented in Table 1.

The investment behavior study, specifically in the private sector, results from the fact that this is a typically endogenous variable and from the observation that the adoption of specific economic actions in the market will increase the relative importance of private investment in the creation of aggregated capital. The methodology in the analysis of the private investment should address two important issues: (1) the endogenous investment's nature with respect to the rest of economic activity; and (2) the government intervention's impact.

3. Methods and data

Time series macroeconomic data is often non-stationary, which makes regression results unreliable. Before developing our regression model, we tested all variables because of stationarity and co-integration.

The data covers the time period from 1996 to 2011. This timeframe is relevant for the determination of Brazil's private

Table 1
Macroeconomic variables' comparison used in Brazil and abroad

Methods and variables	Luporini & Alves (2010)	Santos & Pires (2007)	Ferreira (2005)	Serven (2002)	Rossiter (2002)	Melo & Rodrigues Junior (1998)	Rocha & Teixeira (1996)
Sampled country	Brazil	Brazil	Brazil	61 Countries	USA	Brazil	Brazil
OLS	X	–	X	–	–	X	X
Private investment	X	X	X	X	X	X	X
Tax	–	X	X	–	–	–	–
Capacity utilization	X	–	X	–	X	–	–
Credit	X	–	X	X	X	–	–
Public investment	X	X	X	X	X	X	X
Relative prices of capital goods	–	X	X	–	–	X	X
Inflation (uncertainty)	X	–	X	X	–	X	–
GDP	X	X	X	–	X	X	X
Capital cost (r)	X	–	X	X	–	X	–
Dummies (crisis)	–	–	–	–	–	–	–
External debt	X	–	–	–	–	–	–
R^2	0.92092	–	0.9521	N/A	N/A	0.89	0.85
Log variables	Yes (except r)	Yes	Yes (except r)	Yes (except r)	Yes	Yes (except r)	Yes

Source: Authors.
GDP, Gross Domestic Product; N/A, not available; OLS, Ordinary Least Square.

sector´s investment analysis because within this period Brazil had two presidents with different political and economic government interventions as well as a different international economic crisis which affected the Brazilian economy considerably.

3.1. Econometric model

To exam the private investment's (PI) determinants in Brazil we considered the following variables: GDP (Y), utilization of the industrial capacity (UIC), public investment in infrastructure (PIInfra), public investment in non-infrastructural areas (PINInfra), real interest rates (R), capital goods' relative prices (RP), inflation (IGP-DI), real disbursement of the BNDES (Cred), tax burden (T), and exchange rates (ER).

GDP and the industrial capacity's utilization are commonly used factors in the literature, as they reflect the aggregate demand and are used to measure the investment's accelerating effect and the economic cycles. Typically in pro-cyclical economies, such as the ones in developing countries, they tend to show a stronger correlation between private investment and the variables related to the aggregate demand.

To measure the public investment's impact on the private investment, we used the public investment in a disaggregated form, separating public investment in infrastructure from the investment in electric energy, telecommunications and transportation. All other public investment was considered non-infrastructural. Because of the public investment's importance we verified if there was a crowding-in theoretical empirical evidence effect of the public investment in infrastructure over Brazil's private investment, and if not, did the expected crowding-out effect occur?

The possible crowding-in effect of the public over the private investment in infrastructure can be theoretically explained by the fact that this kind of investment increases the capital's productivity for future investments, and saves the private investors from additional investment that they would otherwise have do make in these areas. As for the crowding-out non-infrastructural public investment effects, these can be theoretically explained by the competition between them for the scarce resources that are available for investment (Ferreira, 2005; Melo & Rodrigues Junior, 1998; Rocha & Teixeira, 1996; Studart, 1992).

A variable that is frequently used to explain private investment is the real interest rate, which is the first theoretic proxy of opportunity capital cost. Inflation is also a commonly used variable as a proxy for macroeconomic uncertainties in developing countries.

A proxy variable for the credit availability in the economy is also commonly used in investment studies, especially in developing

countries, where the access to credit is very limited. Obtaining credit or not is, in many projects, a key determinant of whether the project will materialize or not. We considered the volume of annual BNDES' disbursements (National Bank of Economic and Social Development) as a proxy for credit availability in Brazil.

The total tax burden (as a percentage of the GDP) is used in a few of the empirical articles but, in the Brazilian case, it is relevant due to the significant taxes' increase over the last few years. This study has the added benefit of being able to check whether the tax reform made a difference in encouraging private investment. Another reason for using this variable is the fact that the economic agents of the public and private sectors have been complaining about the excessiveness of Brazilian taxes as being one of the major obstacles for private investment.

Several indicators are used to capture economic instability, such as the commodity prices' deviation, prices from their long term trends, the stock market's volatility, the inflation rates and/or of exchange rates' variability in relation to the debt/GDP ratio, with negative results for private investment (Dailami, 1987; Cardoso, 1992; Jacinto & Ribeiro, 1998; Melo & Rodrigues Junior, 1998; Ribeiro & Teixeira, 2001; Studart, 1992).

And finally, Cardoso (1992) uses the relationship between external debt and exports to be able to investigate the effects of external conditions on the private investment in Brazil, as also in other Latin American countries, confirming the negative results already uncovered in other studies. Ribeiro and Teixeira (2001) investigated the relationship between exchange rates and private investment. The results indicate that the exchange rates affected negatively and significantly the private investment over the analyzed timeframe, which was from 1956 to 1996.

Based on what was discussed above, we propose the following regression model for the 1996-2011 timeframe, which expresses the variables in natural logarithms (except for the real interest rates and external indebtedness), in order to directly obtain the factors' elasticity:

$$LnPI_t = \beta_0 + \beta_1 LnY_t + \beta_2 LnUIC + \beta_3 Ln\ PIInfra + \beta_4 Ln\ PINInfra + \beta_5 R + \beta_6 LnRP + \beta_8 LnCred + \beta_9 LnT + \beta_{10} LnER + \beta_{11} D1 + \varepsilon_t$$

In which:

PI = *strictu sensu* private sector's gross investment;
Y = Real Gross Domestic Product (IBGE-Brazilian Institute of Geography and Statistics, 2012);
UIC = utilization of the industrial capacity (%): Getúlio Vargas Foundation annually database;

PIInfra = public investment in infrastructure;

PININfra = non-infrastructural public investment;

R = real interest rate;

RP = capital goods relative prices goods (real gross fix capital divided by real GDP);

IGP-DI = Inflation

Cred = Real disbursement of the BNDES;

T = Tax burden as a percentage of the GDP;

ER = Real exchange rate;

Dummy = control variable for the years with international crises (0 = year with non-international crisis; 1 = year with international crisis);

ε_t is a random disturbance.

In line with the investment accelerator's model, we expect that the GDP is associated to an increase in private investment (Ferreira, 2005). Economic agents expand production when they experience and/or anticipate higher demand. The effect of the interest rate is negative and reflects the adverse impact of the capital cost's utilization over investment decisions. Used as a proxy for uncertainty and instability, we expect that the elevation in the inflation rates will decrease investment in the private sector; here the implicit hypothesis is that instability increases the waiting price for new information and increases business risks.

Table 2
Candidate variables for private investment

Pre-candidate variable	Expected sign
Real GDP	Positive
Average utilization of industrial capacity	Positive
Public investment in infrastructure	Positive
Non-infrastructural public investment	Negative
Real interest rates	Negative
Relative prices of capital goods	Negative
Inflation	Negative
Real disbursements of the BNDES	Positive
Tax burden as a percentage of the GDP	Negative
Real exchange rates	Negative

BNDES, National Bank of Economic and Social Development; GDP, Gross Domestic Product.

Table 2 presents a summary of the pre-candidate variables used to explain private investment in Brazil, in annual series since 1996 and what are the theoretic expected signals.

4. Results

For the econometric analysis of all the variables, with the exception of the real interest rates, they were log-linearized using the natural logarithm, and the series were calculated using the fixed prices as in 1995. Because the series used in the investment equations' are temporal series, we presume that these series are random variables ordered over time. The usual methods of estimation and inference presume that these variables are stationary. The non-stationarity of a stochastic process is due to the existence of a unit root or a stochastic. To be able to apply the estimation methodology, we first tested all the series for stationarity.

4.1. Stationarity tests

Initially the series were subjected to augmented Dickey and Fuller (t-ADF) unit root tests (Dickey & Fuller, 1981), in level and in first difference. The ADF test is well known and will be described in this section (Hayashi, 2000, p. 573).

The objective of these tests is to show the variables integration order's statistical evidence and is, in fact, a pre-tests for co-integration since, theoretically, only the variables with the same integration order can co-integrate.

According to Braga (2008), the null hypothesis is that $\alpha=0$, where α is the coefficient on the first lag on the series, which enters as an explanatory variable in a regression of the contemporaneous differences of the series on their first lag. The criterion of rejection indicates rejecting H_0 if $|ADF|>VC$, in which VC is the critical value of the distribution. As in the case of the existence of a unit root, the asymptotic distribution of t is not the same if the series is stationary (as in this case the Student-t distribution). Thus, we used critical values tabulated by Mackinnon (1996).

Table 3 summarizes the results of the stationarity tests. For the timeframe that was being analyzed, the results of the tests favor the hypothesis of a unit root and also indicate that the series contains a stochastic trend.

Table 3
Results of the stationarity tests for the candidate variables in the private investment model using annual data from 1996-2011

Variables	t-ADF	Critical value test 1% significance	Critical value test 5% significance	Trend	Level of significance (%)	AIC
On level variables						
LnPI	−1,874	−4,0579	−3,1199	K+trend	5	2
LnY	−3,433	−3,9591	−3,0810	K+trend	−	0
LnUIC	−2,342	−3,9591	−3,0810	K	−	0
LnPIInfra	−1,169	−3,9591	−3,0810	K+trend	−	3
LnPININfra	−0,771	−3,9591	−3,0810	K+trend	−	0
R	−1,842	−3,9591	−3,0810	K	−	1
LnRP	−1,206	−3,9591	−3,0810	K	−	0
LnIGP-DI	−5,265	−4,2000	−3,1753	K	−	4
LnCred	−3,982	−4,0044	−3,0988	K	−	1
LnT	−2,062	−4,0579	−3,1199	K	−	3
First difference variables						
DLnPI	−1,874	−4,0579	−3,1199	K+trend	1	3
DLY	−3,433	−3,9591	−3,0810	K+trend	5	0
DLnUIC	−2,342	−3,9591	−3,0810	K	1	0
DLnPIInfra	−1,169	−3,9591	−3,0810	K+trend	1	2
LnPININfra	−0,771	−3,9591	−3,0810	K+trend	1	0
DR	−1,842	−3,9591	−3,0810	K	1	0
DLnRP	−1,206	−3,9591	−3,0810	K	1	2
DLnIGP-DI	−5,265	−4,2000	−3,1753	K	1	1
DLnCred	−3,982	−4,0044	−3,0988	K	1	0
DLnT	−2,062	−4,0579	−3,1199	K	1	2

AIC, Akaike information criterion.
Source: Elaborated by the authors.

The unit root tests for the level variables do not reject the possibility of the existence of a unit root in all cases at a 1% and 5% level, the only rejection occurs for the LnIGP-DI variable. In other words, there are no statistical evidences that the variables are I(0). The analyses of the results indicate that the series for private investment (LnPI), GDP (LnY), utilization of industrial capacity (LnUIC), public investment (PIInfra and PININfra), real interest rates (R), capital goods' relative prices (LnRP), loans from the BNDES (LnCred) and taxation (LnT), may all be considered stationary.

Based on this, there is statistical evidence that the variables in question can be treated as I(1), and that regressions without their levels (log on level, in the case of the specification used here) are possible and will not present dubious results, as long as the conditions of no co-integration are verified. The theory suggests the possibility of a trend, besides the constant, for the formulations of the unit root tests for GDP and investment, and that were properly examined.

For the selected variables' unit root's tests of the first difference, we observed that the results are qualitatively equivalent, as they do not reject the null hypothesis of a unit root in all of the cases at a level of 1%; the only rejection occurs with the DLnIGP-DI variable. In other words, there are no statistical evidences that the variables are I(0).

4.2. Final functional form for annual data related to 1996-2011

Table 4, bellow, shows the candidate variables' summary used to explain private investment in Brazil, in annual series from 1996 onwards, and their expected signs.

In contrast to Ferreira (2005), this analysis opted for including the variables with low significance in the final model LnIGP-DI and LnT.

Furthermore, our analysis specifies a dynamic model, including the lag private investment (DLnPI(-1)) because, by using contemporaneous variables, the model would present problems with the auto-correlation in the residues. The first lag of the private investment variable is commonly used in several studies, due to the fact that some investments cannot be completed in only one year.

For the first equation we used a control variable for the political instability times, represented by a Dummy (D1), which assumes unitary values for the years of 1997 (East Asian Crisis), 1998 (Russian Default Crisis), 1999 (Argentinean Crisis and the Brazilian Currency Devaluation) and 2008 (World Financial Crises).

Overall the model presented a satisfactory coefficient of determination ($R^2 = 0.95$), which is consistent with the majority of the studies shown in Table 1. One can also observe the importance of the investment's irreversibility, reflected in the coefficient on its first lag, which was positive and significant, pointing to the persistent nature of investments.

The signs found for the estimated coefficients are positive, statistically significant and are in accordance to the economic theory, which predicts that the increase in income (LnY) and in the economic activity (Ln UIC) encourages private investment. In the case of the utilization of industrial capacity (LnUIC), we observed the Brazilian economy's extremely pro-cyclical nature, with a positive and significant coefficient (2.86).

These results are compatible with the majority of existing empirical studies concerning the private investments' determinants in Brazil and in other developing countries, where the variables used to assess the conditions of demand were also significant and relevant in the estimated models.

The results show empirical evidence of crowding-in effect of public investment in infrastructure (LnPIInfra) on the private investment, with a positive and significant coefficient. This means that a stimulus of 1% in the public investment for infrastructure, results in a 0.113% increase in the private investment.

As for non-infrastructural public investment (LnPININfra), the sign obtained is negative, which shows that the direction of

the coefficient suggests a crowding-out effect of non-infrastructural public investment. This means that a stimulus of 1% in the non-infrastructural public investment will result in a 0.0741% decrease in the private investment.

The theory suggests that after the initial negative effect of the competition for resources between private and non-infrastructural public investment, it is reasonable to expect that these investment can also contribute to increase the productivity of the private capital to be invested in the future.

In the case of the real interest rates (R), we observed that the coefficient is positive and insignificant in the estimated equation. Although the estimated coefficient signal goes against what was theoretically expected, the coefficient is numerically very close to zero (and insignificant), which indicates that this proxy for the capital cost does not contribute to reduce private investment. This evidence was also found by Reis et al. (1999) and Luporini and Alves (2010), who also estimated equations using macroeconomic data for the 1972-1996 and 1970-2005 timeframes, respectively.

Although capital cost is theoretically important for the determination of the investment, the difficulty to obtain significant coefficients with negative signs for this variable is widely spread in specialized literature. In the Brazilian case, especially, capital cost coefficients so close to zero can be explained, on one hand, by the firms tradition of not seeking external financing, and on the other hand, by the interest rates' volatility during periods with high

Table 4
Private investment determinants

Explanatory variables	Coefficients	Expected signal	Obtained signal
Constant	−9.3598 (−6.0383) [0.0000]	Negative	Negative
DLnPI(-1)	0.4876 (3.76613) [0.0009]	Positive	Positive
LnY	0.510 (1.8263) [0.0697]	Positive	Positive
LnUIC	2.866 (9.7258) [0.0000]	Positive	Positive
LnPIInfra	0.113 (7.3445) [0.0000]	Positive	Positive
LnPININfra	−0.0741 (−8.0360) [0.0000]	Negative	Negative
R	0.0040 (1.9522) [0.0527]	Negative	Positive
LnRP	−1.3593 (−9.8211) 0.0000	Negative	Negative
LnIGP-DI	−0.0474 (0.0522) [0.0000]	Negative	Negative
LnCred	0.1705 (9.791057) [0.0000]	Positive	Positive
LnT	−1.1800 (0.008) [0.0000]	Negative	Negative
LnER	−0.09251 (−2.19204) [0.03720]	Negative	Negative
Dummy 1	−6.45 (−3.0061) [0.9951]	Negative	Negative
R^2	0.956458	Log Likelihood	338.5426
Adjusted R^2	0.953631	Statistic F	338.2824
DW	2.59	Prob(F)	0.0000

Note: statistics are in parentheses and p-values are in brackets.
Source: Elaborated by the authors.

inflation, which makes the interest rates a useless reference for calculating the opportunity capital costs.

Our results also indicate that an increase preferential credit (LnCred), by means of elevating credit operations aimed at the private sector, will increase private investment in the subsequent years, which confirms the hypothesis that Brazilian organizations face credit constraints. Our results are consistent with the studies by Sundararajan and Thakur (1980), Blejer and Khan (1984), García (1987), Leff and Sato (1988), Studart (1992), Jacinto and Ribeiro (1998), and Ribeiro and Teixeira (2001), which include financial variables in their models and that credit availability is one of the relevant variables for private investment in developing countries.

The estimated coefficient on the exchange rates (LnER) is significant with a negative sign, indicating that higher (or weaker Real) exchange rates does not encourage imports of capital goods, and consequently reduces private investment. This result is confirmed by Ribeiro and Teixeira (2001), who found that the first difference in the exchange rates has a significant and negative effect over private investment in Brazil.

Finally, the Dummy which represents the uncertainty caused by international crises, has a negative effect on private investment. Thus, the implementation of responsible and consistent policies to mitigate the negative impact of external crises is crucial to reduce economic uncertainty and encourage private investment in the country.

The obtained data was used to simulate the long term macro-economic perspectives using the Monte Carlo method for the 2011-2017 annually periods for the scenarios and risk evaluation.

4.3. Monte Carlo Simulation (2012-2017)

This section performs a prediction analysis of the long term prospects of the Brazilian economy using a Monte Carlo Simulation method for the period 2012-2017. In the Table 5 we show how each variable behaves in the predictions as well the probability of each event, based on a 95% confidence interval. The results have shown that the variable credit has a maximum possible value of R$ 61 billion with a risk of R$ 510,000.00. The minimum possible value is R$ 20 billion with a risk of R$ 25,000.00.

5. Conclusion

In this study we presented an econometric cross section model in attempt to analyze the main determinants of the private investment in Brazil for the 1996-2011 period, using data from the New National Accounts System of the IBGE (2012), and also we applied the Monte Carlo Simulation method in order to analyze the long term impacts of the macroeconomic variables on the private investment.

Table 5
Monte Carlo Simulation (2012-2017)

Variables	Max	Risk	Min	Risk
Credit (R$ billions)	61,622.47	0.51	20,161.70	0.3
IGP-DI	3.19	0.29	0.31	0.25
Private investment (R$ billions)	212,977.04	0.41	135,191.27	0.4
Public investment in infrastructure (R$ billions)	57,192.54	0.33	17,985.20	0.28
Relative prices of capital goods	1.06	0.25	0.38	0.31
GDP (R$ trillions)	3.5	0.33	1.4	0.63
Real interest rate	33.51	0.92	9.29	0.74
UIC	87.48	0.27	80.20	0.57
Real Exchange Rate	3.95	0.39	1.71	0.37

GDP, Gross Domestic Product; IGP-DI, inflation; UIC, utilization of the industrial capacity.
Source: Elaborated by the authors.

The results show empirical evidence of crowding-in effect of public investment in infrastructure (LnPIInfra) on the private investment and as for non-infrastructural public investment (LnPINInfra), the sign obtained is negative, which suggests a crowding-out effect of non-infrastructural public investment on the private investment.

It is also important to note that unlike the theory, the real interest rates coefficient is positive and insignificant in the estimated equation. We conclude that the result indicates that this proxy for the capital cost does not contribute to reduce the private investment. This is given to the behavior of the Brazilian firms' tradition of not seeking external financing. As for the analyzed macroeconomic variables, the results are compatible with the majority of existing empirical studies concerning the determinants of the private investment in Brazil.

The presence of instability may also be a harmful factor for investment financing, since instability creates uncertainty and hinders long-term funds sources. The negative relationship between interest rates and investment also reflects the entrepreneurs' aversion to uncertainty and instability, since the result suggests that highly volatile foreign exchange periods exert a negative effect upon the private investment.

Finally, the prediction analysis of the Brazilian economy's long term prospects using a Monte Carlo Simulation method for the period 2012-2017, shows that Brazil´s utilization of the industrial capacity is at its limit and the investment's low level in infrastructure restricts a possible increase of industrial growth.

As a result of these analyses, we suggest that more studies should be made in order to simulate the impacts of macroeconomic variables on private investment, by regions and by productive sectors in Brazil, using the Monte Carlo Simulation method, in an attempt to obtain long term estimates.

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