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Full Length Research Paper

Estimating Private Investment Functions for the Brazilian's capital formation industries: Evidence from the panel data and fixed effects models

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This article examines the determinants of private investment in Brazil from sectorial industry data of 1996 to 2010. The series of gross fixed capital ormation, commonly used in empirical studies of aggregate investment eliminates irregular adjustments of individual production units due to the aggregation process. Using the industry's sectorial data it is possible to avoid smoothing in this aggregate series and it may help to understand aggregated investment dynamics. The results reveal the importance of the volume of available funds for investment with the complementarity between public and private investment. The results also indicate that the real high interest rates prevailing in the market did not affect the private sector's investment negatively during the considered period. The investment financing alternative from own resources and subsidized credit seems to be more important. As expected, economic instability adversely affected private investment during this period.

Key words: Panel data, private investment, fixed effects, capital formation.

INTRODUCTION

Almost all economists lay emphasis on capital formation as the major determinant of economic growth. Capital formation means that society does not apply all of its current productive activity to the needs and desires of immediate consumption, but directs a part of it for the making of capital goods, such as tools and instruments, machines and transport facilities, plant and equipment, and all the various forms of real capital that can so greatly increase the efficacy of productive effort.

This consists of adding the producer's assets with tangible reproducible goods, which have an expected lifetime use of one year or more. The producers in question can be industries, government services producers and private household non-profitable service producers. The capital formation is responsible for the machinery and equipment production that are used to produce other goods, always keeping a direct relationship with the production of other industrial segments, besides playing an important role in the creation and diffusion of new technology.

The machinery and equipment industry comprises many other industrial segments, such as machinery and equipment manufacturing; automotive vehicles, trailers and vehicular bodies; electrical machines, devices and materials; information technology equipment and peripherals and communication equipment.

The investment in equipment does not only increase production but also increases opportunities. Capital formation leads to technical progress, which helps to use the economies of large-scale production and increases specialization. It provides machines, tools and equipment for the growing labor force. Thus, capital formation also benefits labor.

The most important capital formation industry segment in the Brazilian economy is the machinery and the equipment-manufacturing sector, which is concentrated in the State of São Paulo. In 2010, according to the IBGE Census Bureau, São Paulo accounted for 57% of ITV –

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Industrial Transformation Value, or $8.7 billion, and for 53% of all employed labor (198,000 employees) by this industry in the country. It ranks among the five first major activities in the São Paulo industrial structure.

According to De Oliveira et al. (2012b), Brazil needs to improve its investments in infrastructure, given the limited usage capacity by the national industry. The authors demonstrate that an increase in the credit supply through an increase of credit operations for the private sector has as result an increase of private investment in subsequent periods. Another relevant fact is that, due to the effects of the high interest rates over the financial fundings for the private investment, the Brazilian businesses end up having to use their own resources to finance their investments, as also the scarce availability of resources. This study indicates the need of investments in industries such as the machinery and equipment manufacturing industry, the automobile, trailers and body work manufacturing and assembly sectors, and other transportation equipment.

Seeking to encourage economic growth, the Federal Government announced its PAC – Growth Acceleration Program for Equipment. The purpose is to make available R$8.4 billion to streamline government procurement, giving preference to products of the national industry. This is another series of measures with the objective of avoiding the reduction of the Gross Domestic Product (GDP), the sum of all the possessions and services produced in the country, due to the international crisis initiated in 2008.

In order to implement this program, the National Economic and Social Development Bank – BNDES created specific financing investment programs to modernize the industry, such as the BNDES PSI program – Producers' Goods, for the production and pacquisition of new machinery and equipment; as well as, the Industrial Production Capacity Program, which is focused on the implementation, modernization and expansion of the industries that produce machinery and equipment, among others.

According to De Oliveira et al. (2012a), the determinants of private investments in Brazil are not only associated with the economic performance, but also depend on the behavior of all sectors. In this perspective, it is necessary to develop new studies, in order to better understand the most representative segments of the country's economy.

Thus, the objective of this study is to estimate private investment functions in the Brazilian capital formation industrial sectors using the panel econometric model with fixed effects of 1996 to 2010.

LITERATURE REVIEW

The literature review identified very few articles that contribute to the econometric studies that analyze sector's performance, especially the financial sector and insertion of products or services. As a result of these analysis, it is essential that data surveys should be conducted to simulate the impacts of macroeconomic variables on private investments by the productive sectors in Brazil (De Oliveira et al., 2012a).

According to De Oliveira et al. (2012b), there is a great need of improvements in the electric power segments, tele communications, road, rail and air transportation, harbours, waterways and sewage systems, as also in a model where private investment offers substantial returns, becoming in this manner more attractive than the public investment. Capital formation industry sectors, such as, machinery and equipment manufacturing industries, themotor vehicles, trailers and body works manufacturing and assembly sectors, and other transport equipment sectors are essential sectors related to these needs.

The capital formation industry is directly related to the production of the remaining industrial sectors, and plays a prevalent role in the diffusion of new technologies. This industry can be characterized by its heterogeneity, given the substantial variability of product types, applications and purposes and by its competitive market conditions.

Besides being directly related to the production chains of other industries, the capital formation industry is also a consumer of the goods it makes. Therefore, the industry plays a prevalent role as an economic growth driving industry. It comprises a set of products for different applications, which can be grouped as follows.

Mechanical capital goods – mechanics, mechanical equipment, industrial equipment, farm machinery and implements, mining machines and highway machines;
Transportation equipment – buses and trucks, shipbuilding, aeronautic industry;
Electrical capital goods – electrical equipment.

According to the data from the Brazilian Association of Machinery and Equipment, the sector is setup as indicated in Table 1. The data indicate that the Brazilian mechanical capital goods ended the year 2011 having an actual gross turnover of R$ 81.2 billion, which represents a growth of 9.2% above the results of 2010. The sales from January through December of 2009 were of R$ 64.05 billion.

Table 1 shows that farm machinery and wood working machines are the most important segments with a sales increase of 30.1 and 48.2%, respectively. On the other hand, textile machinery, plastic-working machines and valves – which already had a small share in the capital goods industry – continue to face challenging conditions and ended the year 2011 with turnovers smaller than those of 2010.

In the first half of 2012, the Trade Balance recorded a

Table 1. Mechanical capital goods actual gross sales by segment in 2011.

Segment	Percentage	Actual gross sales in R$ billion
Other machines	57.5	8.1
Made-to-order goods	16.6	6.2
Farm machinery	12.4	30.1
Pumps and motor pumps	5.9	6
Hydraulics and pneumatics	2.0	14.7
Machine tools	1.9	1.7
Valves	1.3	- 18.1
Plastic-working machines	1.2	- 14.3
Woodworking machines	1.0	48.2
Textile machines	0.2	- 45.5

Source: ABIMAQ (2012).

larger deficit of 5.2% than that of last year's, which is same period for the machinery and equipment manufacturing industry. Altogether, the capital goods industry reported an R$ 9,244 billion deficit, compared to the R$ 8,784 billion recorded between January and June of 2011 (BACEN, 2012). Exports alone accrued an 11.6% increase in the year, and amounted to R$ 5,987 billion in the period. Conversely, imports reported R$ 15,231 billion, for a 7.6% growth compared to the first half of 2011. Exports presented a good performance in the first quarter alone, which grew by 29.4% if compared to March 2011, while imports dropped by 1.5% in the same period.

The Latin American region, notably, represents the main destination of Brazilian capital goods exports; however, the share of this destination in the exported volumes has lost its momentum, including the results from Mercosul, which dropped from 41% in the first quarter of 2011 to 33% in 2012 (ABIMAQ, 2012).

Imports keep increasing, with the exception of the machinery group for consumer goods that recorded a result below the numbers of the first quarter of previous year. The groups with the most significant growth were the farm machinery, machines for logistics and construction engineering and for the manufacturing industry. The United States, China and Germany are the main origins of machinery and equipment imports.

In sales terms, the machinery and equipment manufacturing industry ended the first half of 2012 with the gross sales amount of R$39,932 billion, which represents a growth of 2.1% increase over the equal period of 2011.

De Oliveira et al. (2012b) suggested investments in the infrastructure, logistics areas and some segments of the transformation industry, as confirmed by the Brazilian Growth Acceleration Program (PAC).

MATERIALS AND METHODS

The quantitative research used explains the theoretical regression model and also tests the existence of stationarity and the co-integration between the used time series data. The used econometric method used is the panel data with fixed effects.

Panel data or longitudinal data are characterized by observations with two dimensionswhich are often time and space. These data contain information enabling a better research about the dynamics variables change, making it possible to consider the effect of unobserved variables. Another important aspect is the improvement in the parameter inference that was studied, since it provides more degrees of freedom and a greater variability in the sample, when compared with the data in cross-section or time series, which refines the efficiency of econometric estimators. Hsiao (1986, 2006) presents a more detailed analysis of the advantages in using thePanel Data.

Generally, the panel data cover a small period of time, due to the high cost of obtaining new information or information unavailability in the past. As the estimated parameters are asymptotically consistent, it is desirable to have a large number of observations. Accordingly, when the covered time period is small, the property of consistency will be satisfied if the number of subjects is large. The following section presents the general model for panel data and fixed effects model used in this study.

General model for panel data and fixed effects model

$$y_{it} = \beta_{oit} X_{1it} + \cdots + \beta_{kit} X_{kit} + \varepsilon_{it} \quad (1)$$

In this notation, the subscript *i* denotes the different individuals and the subscript *t* the time period being analyzed. The β_0 refers to the intercept parameter and β_k refers to the angular slope coefficient correspondent to the k^{th} explanatory variable of the model.

In this general model, the intercept and response parameters are different for each individual and for each time. There are, therefore, more unknown parameters than observations, not being possible, in this case, to estimate their parameters.

Thus, it is necessary to specify assumptions about the general model in order to make it operational. Among the models that combine time series data and cross-section, three are the most used: Seemingly Unrelated Regressions Models (SUR), Random Effects Models and Fixed EffectsModels, being the latter applied in this research.

The fixed effects model aims to control the effect of omitted variables that vary between individuals and remain constant over time. For this, it is assumed that the intercept varies from individual to individual, but is constant over time, whereas the response parameters are constant for all subjects and for all time periods.

According toHill et al. (1999), the model assumptions are:

$$\beta_{0it} = \beta_{0i}\beta_{1it} = \beta_1 \cdots \beta_{kit} = \beta_k \quad (2)$$

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The fixed effects model is therefore given by:

$$y_{it} = \alpha_i + \beta_1 X_{1it} + \cdots + \beta_k X_{kit} + \varepsilon_{it} \quad (3)$$

In this model, the intercept is a fixed and unknown parameter that captures the differences between individuals that are in the sample. Thus, the inferences made about the model are only about individuals, which provide the data.

It is possible to make a specification of the fixed effects model using dummy variables to represent the intercepts for each specific individual. In this case, the general equation is defined as:

$$y_{it} = \beta_0 + \beta_1 X_{1it} + \cdots + \beta_k X_{kit} + \gamma_1 D_{1i} + \gamma_2 D_{2i} + \cdots + \gamma_n D_{ni} + \varepsilon_{it} \quad (4)$$

Where, D_{ni} represents a binary variable for each individual and is equivalent to one when *i=n* and zero, otherwise. However, this equation shows a binary variable for each individual, resultingin the problem of perfect multicollinearity. To clear up multicollinearity we should omit a binary variable. Thus, the model proposed byStock and Watson (2004) will bewritten as:

$$y_{it} = \beta_0 + \beta_1 X_{1it} + \cdots + \beta_k X_{kit} + \gamma_2 D_{2i} + \cdots + \gamma_n D_{ni} + \varepsilon_{it} \quad (5)$$

Thefixed effects model is the best option to model the panel data when the intercept α_i is correlated with the explanatory variables in anytime period. In addition, as the intercept of this model is treated as a fixed parameter, it is also desirable to use fixed effects when the observations are obtained from the entire population and you want to make inferences for individuals that have the data.

The applied econometric model is intended to test the hypothesis that the series of private sector investment, the gross value of industrial production sector, public administration's investment, interest rate, among others are co-integrated, which allows the modeling of the long-term private investment behavior. Through anempirical study, we will seekto identify whether there is a role in inhibiting private investment played by macro economic instability and by government's investment, during the proposed period.

To explain the sectorial private investment, the following data were chosen to integrate the functional form: the Gross Sectorial Industrial Production Value, Sectorial Industrial Capacity Use, Government Investment, and Actual Interest Rates, a proxy for Credit Availability, External Restrictions and Foreign Exchange.

Due to the above-exposed, the following generic theoretical model is proposed:

$$Invest\_priv = f(VBPI, UCAP, R, Cred, FBKF, E, EE) \quad (6)$$

Where, Invest_priv = a proxy for sectoral investment spending; data refer to Fixed Assets Acquisitions (machinery and equipment) by industrial segments (the transformation Industry), in thousands of Reals, at 1995 prices; VBPI = a proxy for the economic activity level; data refer to the Gross Industrial Production Value per industrial segment, in thousands of Reals, at 1995 prices; UCAP = Capacity Utilization rate (%) – time series data for installed capacity utilization by industrial segment are available at Fundação Getúlio Vargas (FGV) and were made compatible for the CNAE according to information provided by the IBGE Census Bureau; R = Actual Interest Rate (%), representing the nominal interest rate on Bank Certificates of Deposit (BCD) as deflated by the General Price Index (IGP-DI) and annualized, provided by the Brazilian Central Bank (BCB); Emprest_BNDES = Credit Indicator – represented by Credit disbursements made by the National Bank for Social and Economic Development (BNDES), available for each segment of the transformation industry, in millions of Reals, at 1995 prices; FBKF = Government Investment – represented by the Fixed Capital – Gross Formation – Public Administration series, in millions of 1995 Reals, applying the GDP deflator as computed by the data available from the IBGE Census Bureau/ National Accounts System; EE = External Restriction – the proxy used is the annual Debt Service/GDP (%) series provided by DEPEC-BCB, Central Bank of Brazil (BCB); E = Actual Foreign Exchange Rate; D1 = Dummy control variable for international crises periods.

From the previous expression, the following general econometric model was estimated for the period between 1996 and 2010, with the variables expressed in natural logarithms (except for actual interest rates) such as to directly derive variable elasticities:

$$LogInvest\_priv_t = \beta_0 + \beta_1 LogVBPI_{it-1} + \beta_2 LogUCAP_{it} + \beta_3 R_{it} + \beta_4 LogCred_{it-1} + \beta_5 LogFBKF_{it-1} + \beta_6 LogE_{it-1} + \beta_7 LogEE_{it-1} + \beta_8 LogEE_{it-1} + \beta_9 D1 + \varepsilon_t \quad (7)$$

In which ε_t is a random disturbance.

The period under analysis is justified by the fact that sectoral data are limited due to changes in CNAE nomenclature and by the unavailability of more recent data.

For the estimates, the data used were from the Brazilian Institute of Geography and Statistics (IBGE, 2012), which are available in the Annual Industrial Survey and are broken down by sector, according to the national classification of economic activities (CNAE) for the period of 1996 to 2010. This periodization is due to data availability of PIA, which, since 1996, has changed the classification in terms of the division of activities and sampling methodology.

Table 2 presents three sectors of the Brazilian manufacturing industry, according to the division of activities, and their CNAE classification, which identifies the industrial sectors.

RESULTS

For the econometric analysis, all variables, except the real interest rate, were log-linearized using natural logarithm. The usual estimation methods and inference assume that these variables are stationary. The non-stationarity of a stochastic process is due to the existence of a unit root or stochastic trend in autoregressive process (AR) that generates the variable, and tests on the unit root hypothesis, in order to help to evaluate the presence (or absence) of stationarity in the variables used in these estimations.

As in the study of time series, the existence of a unit root in panel data may cause estimated econometric relations to become spurious. To avoid this problem, variables were tested for the Levin unit root: Lin and Chu (LLC), Im, Pesaran and Smith (IPS), FisherADF and FisherPP. The test LLC assumes the existence of a common root unit, such that ρ_i is the same for all cross-sections, or all industrial sectors (where the auto-correlation coefficientis $\alpha = \rho - 1$). The tests IPS, Fisher-ADF and Fisher-PP assume that the coefficient ρ_i may

Table 2. Brazilian capital formation industrial sectors.

CNAE	Transformation industry
29	Manufacture of machinery and equipment
34	Manufacture and assembly of motor vehicles, trailers and bodies
35	Manufacture of other transport equipment

Table 3. Level stationarity tests results for variables in the private investment model.

Commo unitary root	Individual unitary root				
	LLC	IPS	Fisher ADF	Fisher PP	Integration order
LnInv_Priv	-3.0204	-2.0946	15.4443	15.5092	I(0)
LnVBPI	-2.4586	-0.3463	7.4197	19.8849	I(0) ou I(1)
LnUCAP	-1.2232	-1.2507	3.0069	7.0761	I(0)
R	-6.1459	-2.4812	20.9721	18.4267	I(0)
LnFBKF	-15.0851	-6.1227	66.2767	72.6854	I(0)
LnCred	-9.4456	-4.7382	45.6314	50.9166	I(0)
LnE	-1.9957	-0.0058	33.8701	36.5349	I(0)
LnEE	-10.346	-4.5487	90.4013	100.5060	I(0) ou I(1)

Source: Research results.

vary according to the industrial sectorin question, characterized by the combination of individual unit root tests, by deriving a panel specific result. The number of lags in each case was determined by Schwarz's information criterion (SC).

The analysis, presented in Table 3, indicates that most of the series are stationary; in other words, do not present a unit root. For some variables, however, such as exchange rate and industrial production, the tests confirm the absence of a unitary common root, but do not eliminate the possibility of an individual unit root, which means that the average of each panel *t*-statisticsindicates that the series can be non-stationary.

In the case of the VBPI variable, a possible explanation for this is the heterogeneity between the industrial sectors, which naturally have quantitative and qualitative distinct data. It also suggests the existence of an individual unit root. However, as industrial production exhibits temporal tendency, based on tests LL andFisherPP, we choose to use the variable in levels.

Regarding the macro economic variables (R, FBKF, E, EE), the results for the considered period (1996 -2010) indicate that these are stationary, not showing neither common unit root nor individual. The only exception made is with relation to the exchange rate series (E), which needs to be differentiated to become stationary.

Initially, to identify the feasibility of using the panel data methodology, the models are estimated by Ordinary Least Squares (OLS), with all the pooled units (pool cross-section or pooling); in other words, without taking into account the possible specific sector's effects.

The existence of specific factors in each sector can be tested by the hypothesis that there are significant individual effects in the regression through a joint restrictions F test. If the value of the F's statistic exceeds the critical value, there are evidences that specific sectoral effects are present in the estimated model (Greene, 1999).

The F test (Ho:fixed effects =0) results suggest that using the panel data methodology provides relevant information gain, and in this case, the OLS estimation (pooling) may generate biased results. As the panel data methodology is the most appropriate, the issue now is to choose the estimation method for fixed effects (FE) o rrandom effects (RE).

In this case, in which the used data are not random extractions from a larger sample, the fixed effects model is the most appropriate estimation method. Furthermore, in the fixed effects model, the estimator is robust to the omission of relevant explanatory variables that do not vary over time, and even when the random effects approach is valid, the estimator of fixed effects is consistent, but less efficient. Therefore, the estimation by fixed effects appears to be the most appropriate for sector's investment models.

The investment equations are estimated by fixed effects and are robust to the presence of multicollinearity between variables, estimated by the Generalized Least Squares method (GLS) with weighting for individuals (industry sectors), which makes the model also robust to the heteroscedasticity between the individual error terms. Moreover, standard deviations were calculated by the

Table 4. Investment sectorial equations.

Estimation by Fixed Effects - Dependent Vabriable: Private Investiment 1996-2010							
Explanatory variables [(1)]	**EQ1**	**EQ2**	**EQ3**	**EQ4**	**EQ5**	**EQ6**	**EQ7**
C	-2.2574	-1.9176	-1.4650	-3.0611	-6.4315	-11.0640	-13.9077
	[-0.3120]	[-0.2579]	[-0.1788]	[-0.4179]	[-0.8675]	[-0.9718]	[-1.1724]
	(0.7570)	(0.7981)	(0.8592)	(0.6788)	(0.3921)	(0.3392)	(0.2509)
LnVBPI(-1)	0.6134	0.8560	0.6171	0.6108	0.6900	0.9317	0.8993
	[3.0732]	[3.5707]	[3.0361]	[3.0476]	[3.4756]	[3.8041]	[3.6193]
	(0.0042)	(0.0011)	0.0047	0.0046	(0.0015)	(0.0007)	(0.0012)
LnUCAP	1.1611	0.2673	1.1255	1.2991	1.7204	1.1576	1.6455
	[0.6921]	[0.1461]	[0.6581]	[0.7677]	[1.0372]	[0.5824]	[0.7956]
	(0.4937)	(0.8847)	(0.5152)	(0.4482)	(0.3074)	(0.5647)	(0.4329)
R	0.0197	0.0215	0.0192	0.0219	0.0209	0.0256	0.0322
	[1.5618]	[1.7484]	[1.4729]	[1.6920]	[1.7061]	[1.9003]	[2.0886]
	(0.1279)	(0.090)		(0.1004)	(0.0977)	(0.0674)	(0.0460)
LnCred(-1)		0.2900				0.2393	0.2663
		[1.7212]				[1.3930]	[1.5217]
		0.0949				(0.1742)	(0.1393)
LnFBKF (-1)			0.0710			0.4529	0.6076
			[0.2179]			0.9280	[1.1694]
			(0.8289)			0.3610	(0.2521)
LnE(-1)				-0.2242		-0.1241	-0.3793
				[-0.8581]		[-0.2893]	[-0.7336]
				(0.3972)		(0.7744)	0.4693
LnEE(-1)					-0.2346	-0.4298	-0.5134
					[-1.7488]	[-1.8332]	[-2.0269]
					0.0899	(0.0770)	(0.0523)
Dummy							-0.1906
							[-0.8914]
							(0.3803)
R-squared	0.9204	0.9272	0.9206	0.9222	0,9274	0.9370	0.9387
Adjusted R-squared	0.9084	0.9135	0.9057	0.9077	0.9138	0.9174	0.9768
S.E. of Regression	0.3382	0.3286	0.3432	0.3396	0.3281	0.3211	0.3222
SSR	3.7757	3.4557	3.7701	3.6907	3.4463	2.9909	2.9084
Log Likelihood	-9.8066	-8.0800	-9.7776	-9.3629	-8.0265	-5.2633	-4.7175
DW stat	1.2576	1.4946	1.2753	1.2955	1.2964	1.6326	1.5897
Prob (F-statiscs)	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000

Source: Research findings. (1) t-statistics in brackets, followed by p-values in parentheses.

White matrix (period) making them robust to the serial correlation and heteroscedasticity in the model´s time dimension. The results are presented in Table 4. The results in the table indicate that the quantitative variables, Gross Value of Industrial Production (LogVBPI) and utilization of industrial capacity (LogUCAP) were relevant in explaining private investment. The signs found for the estimated coefficients were positive.

The coefficient for real interest rate (R) is positive which is contrary to the theory of investment. However, the magnitude of the coefficient is close to zero, indicating that changes in the levels of real interest rates for the period 1996 to 2010 do not affect the decision making of private sector investment.

Despite the theoretical importance of the investment opportunity cost, the difficulty of finding negative and significant coefficient for this variable is abundantly reported in the literature (Chirinko, 1993). In the Brazilian case, the result found for the interest rates effect upon private investment can be explained by the common practice of Brazilian companies resorting to their own retained earnings to fund their investments. Another

possible explanation for the result is that the interest rate may be related to the low availability of funds.

The importance of credit availability on the private investment is confirmed in Equation 2 (EQ2). The results show that increases in credit supply through the increases of BNDES's credit disbursements system intended for industrial sectors increase the investment in subsequent periods, unveiling the importance of offering long-term financing lines funded with stable amounts, and designed to finance the private sector's investment projects.

The impact of public investment on the private sector's investment is tested in Equation 3 (EQ3). The variable public investment coefficient (FBKF) is significantand has a positive sign, indicating that public investment tends to complement private investment.

The estimated coefficient for the exchange rate is negative (see EQ4 in Table 4), suggesting that a more depreciated exchange rated encourages the import of capital goods, at least in the short term, and increases the financial commitments of companies' external indebtedness.

In relation to external debt, the Equation 5 (EQ5) indicates the existence of a negative relationship between investment and external debtservices. In recent years, the existence of external constraints may have limited private sector's investment. This can be explained by the increase of the private sector's external debt in the 1990s and the decrease of thepublic sector's participation in the fund raising and financing investment programs.

Equation 6 (EQ6) tests all the variables together, but without the dummy variable control. The signs are coherent with the theory and they were the same if compared with the equations that were tested with each variable separately.

Finally, a variable control was included in the estimated Equation 7 for periods of economic instability, represented by a Dummy (D1), which assumes unit values for 1997 (Asian Crisis), 1998 (Russian crisis), 1999 (Argentina Crisis and Brazilian Exchange Rate Devaluation) and 2008 (World Crisis) and zero for periods without crisis. It is observed from the results, a negative coefficient which indicates a negative effect on private investment variable.

Coefficients with fixed effects

To evaluate the specificities of each sector, we estimated the magnitude of sectoral fixed effects. Each estimated sector coefficient corresponds to the pure effect of each sector, that is, the difference in the average investment of a particular sector, compared to the annual average for the sector, which is not due to the variations in the dependent variables (Greene, 1999). Thus, the co-efficient represents the actual investment related to the specific factors of each industry sector, regardless the included variables in the model.

Table 5 shows the estimated coefficients sectors. It is noted that the coefficients signs vary according to the sectors, and also show the distinctive magnitudes among the sectors and models. The sectors with positive co-efficients have invested relatively higher than other sectors during the period in question, regardless of the changes in the explanatory variables that were considered in the model. On the other hand, sectors that exhibit negative coefficients are those who, without taking into account variations in the explanatory variables, had a level of investment below the annual average per sector. The results presented in Table 5 indicate that sector 29 (Manufacture of machinery and equipment) and sector 34 (Manufacture and assembly of motor vehicles, trailers and bodies) showed positive signs. It is observed that the intensity varies with the inclusion of the tested variables along the equations. The Brazilian industry sectors that have reduced coefficients, close to zero, invest relatively more according to changes in the explanatory variables; in other words, have few specific effects and are fairly well represented by the estimated models.

The case of sector 29 (Machinery and Equipment) is symbolic in this aspect. Thus, it can infer that the credit variable (EQ2), pointed out by the economic theory, as an indicator to determine investment in developing countries, is also included in the models that most explain investment in the Brazilian economy.

As for the sectors that have more specificity, they tend to have higher sectorial coefficients, indicating that they invest according to other factors, other than those identified in empirical models. This situation can be observed by the sector 35 in the Equations1, 3, 4 and 5. Sector 35 (Manufacture of other transport equipment) showed a negative sign, which means that it had an investment below the annual average level per sector. The negative sign can be explained byseveral reasons: international policies effects (trade liberalization and exchange arte), international crises or also because of its low technological intensity.

Finally, a comparative analysis suggests that Equation 2, which tests the hypothesis of credit constraints, presents lower sectorial magnitude coefficients for the three analyzed sectors, followed by Equations 6 and 7. This means that these two last models are perhaps the best ones to reflect the investment sector of the manufacturing goods industries that were analyzed in this study.

Conclusion

This study analyzed preliminarily the main determinants of private investments for a few segments of the Brazilian capital goods industry, as of a panel analysis of the period between 1996 and 2010.

Table 5. Coefficientswith fixed effects.

Sectors	EQ1	EQ2	EQ3	EQ4	EQ5	EQ6	EQ7
29(1)	0.1891	0.1320	0.1865	0.1970	0.2063	0.0322	0.0190
34(2)	0.5926	0.5323	0.5918	0.5864	0.4999	0.3801	0.3807
35(3)	-0.7817	-0.4003	-0.7783	-0.7835	-0.7054	-0.3478	-0.3617

Source: Research findings.(1) Manufacture of machineryand equipment; (2) Manufacture and assembly of motor vehicles, trailers and bodies; (3) Manufacture of other transport equipment.

The estimated investment models have confirmed the relevance of the quantitative Gross Industrial Production Value and Capacity Utilization variables to explain private investment. The relationship found between the interest rate and private investment were positive and significant in the sectoral models, but the coefficient found is close to zero, suggesting that the actual interest rate increase between 1996 and 2010, dooes not exert a negative impact over the private investment.

This empirical evidence, apparently contradicting the economic theory, may be related to this country's private investment financing conditions, which, because of the low volume of available resources, limits the businesses investments to the use of retained earnings and bank credit.

Sectoral results also indicated that increases in the credit supply through the increases of BNDES credit system disbursement increased private investment in subsequent periods, confirming the hypothesis that Brazilian companies depend upon long-term funds offered by official development agencies.

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 differentiated 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. A devaluated foreign exchange rate also discourages capital goods imports and raises the financial liabilities of foreign-indebted companies, which decreases investment in the economy.

The industry-estimated coefficients (individual sectors effects of the processing industry) suggest that certain sectors, such as the industry responsible for manufacturing of other transport equipment showed a negative sign, meaning that they had a level of investment below the annual average per sector. On the other hand, the other two sectors analyzed indicate that the manufacturing machinery and equipment sector and the manufacturing and assembly of motor vehicles, trailers and bodies sectors showed positive signs. These sectors had invested relatively more in accordance with the changes in the explanatory variables.

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