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ScienceDirect

EconomiA 18 (2017) 73–87

ECONOMIA

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Credit scarcity in developing countries: An empirical investigation using Brazilian firm-level data☆

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Received 21 April 2015; received in revised form 30 July 2016; accepted 4 December 2016
Available online 16 December 2016

Abstract

The aim of this paper is to investigate whether Brazilian manufacturing firms are credit constrained. We exploit a rich database that contains more than three thousand firms with characteristics that may affect their degree of credit constraint: size, being listed in the Brazilian stock market and level of exports-sales ratio. Our results show that all dimensions considered here may affect the sensitiveness of investment to cash flow. Large firms, stock market listed firms as well as firms with better export capacity are associated with inexistence or less credit restriction. Specifically, considering firms' size, our results corroborate the economic theory prediction and empirical international literature. Furthermore, the influence of being listed in the stock market and export capacity is beyond any possible correlation with size. Even small and middle firms are not credit constrained when listed in the stock market or when the exports-sales ratio is higher.

JEL classifications: C23; D21; D92; E22

Keywords: Credit constraint; Firms' investment; Cash flow; Exports; Stock market

Resumo

O objetivo desse paper é investigar se firmas brasileiras do setor industrial são restritas ao crédito. Nós exploramos uma base de dados de mais de três mil firmas com características que podem afetar o nível de restrição ao crédito das mesmas: tamanho; ser ou não listada na bolsa de valores; e a participação das exportações no faturamento. Nossos resultados indicam que todas as categorias aqui consideradas afetam a sensibilidade do investimento ao fluxo de caixa. Firmas grandes, firmas listadas na bolsa de valores tal como aquelas com maior capacidade de exportação estão associadas a inexistência ou mesmo a menores níveis de restrição ao crédito. Especificamente, ao considerarmos o tamanho da firma, nossos resultados corroboram a literatura empírica internacional. Além disso, o fato da firma estar listada na bolsa de valores ou possuir maior capacidade de exportação não estão correlacionadas

☆ The views expressed herein are those of the authors and do not necessarily reflect the views of the Brazilian Development Bank.

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ao seu tamanho. Mesmo firmas pequenas ou médias não são restritas ao crédito quando listadas na bolsa de valores ou quando a participação das exportações nas receitas de vendas é considerada elevada.

Palavras-chave: Restrição de Crédito; Investimento da Firma; Fluxo de Caixa; Exportação e Mercado Acionário

1. Introduction

Credit constraint is a widespread market failure. Under asymmetric information, financial intermediaries provide less credit to firms with good projects but low net worth than would otherwise do with perfect functioning capital markets. The adverse consequences of this market failure are especially damaging to developing countries, because it inhibits entrepreneur capacity to make investments necessary to overcome backwardness, as evidenced by Banerjee and Duflo (2005). Moreover, there is broad evidence that removing credit constraints in fact enables firms to enhance their performance. For instance, Banerjee and Duflo (2014) showed that improving firms' access to direct credit expands production without crowdingout with other forms of credit.

In Brazil, private debt markets to firms are still to be fully developed, especially when it comes to long-term finance. According to CEMEC (2016), total credit (including bank-based and market-based debt) to non-financial firms amounted to 38.7% of GDP in 2015. Nevertheless, long-term outstanding private debt was only 5.8% of GDP. Needless to say that the small- and medium-sized firms, usually more credit constrained, have more difficulties in access to bond markets. Therefore, our investigation might help policy makers to understand where in the Brazilian economy credit restrictions are more severe. As a consequence, government policies should be able to alleviate these constraints more effectively and eventually boost private sector investments.[1]

Given this institutional framework, this paper tests whether Brazilian firms are credit constrained, and further investigates some qualitative properties of this restraint, considering the investment-cash flow model proposed by Fazzari et al. (1988). The main interest in this case is to verify the sensitiveness of a firms' investment to cash flow and interpret it as credit constraint. Our main contribution to the existent literature consists in the use of a richer and still under exploited dataset, which enables us to assess different aspects undermined by previous research. Our dataset gathers balance-sheet information for more than 3000 manufacturing firms with characteristics that may affect the degree of credit constraints, for example, size, the participation in the Brazilian stock market and level of export's sales. Understanding stock market participation as a "domestic" source of external investment's funds and the level of export's sales as a proxy for "foreign" source, once export revenue may be seen as a collateral to gain access to international financing, our results may be seen as a test if substitutes for banking funding are effective in alleviating credit constraints, which may be useful for guiding public policy in broader contexts.

Methodologically, we follow the existing literature, as there is a potential endogeneity between cash-flow and investment, adopting a system GMM approach proposed by Arellano and Bover (1995) and Blundell and Bond (1998). In this case, the lagged explanatory-variables instruments allow us to identify the importance of cash-flows on investment decisions. Despite heterogeneity in our sample, the presence of non-listed firms imposes some difficulties, as regards to the controls utilized in the estimations. In particular, Tobin's Q may not be used as a proxy for investment opportunities. This problem is circumvented by using multiple alternative proxies. For instance, we consider variation of sales at firm level and sector variation in investment and in value added at an aggregate level in order to control for investment opportunities.

Our main results indicate that Brazilian firms were credit constrained in recent years (2008–2010). Cash flow coefficient is indeed larger than what is usually obtained in the literature for other countries, such as Carpenter and Guariglia (2008), suggesting a higher degree of imperfections in the Brazilian credit market. Furthermore, this coefficient changes when firms are classified according to the three categories that may properly approximate the degree of credit constraint: size, listed on stock markets and the export's sales level. In the first case, Brazilian firms are classified as small, middle and large considering the number of employees. Although previous evidence that analyze

[1] Eslava and Freixas (2016) discuss the role of public development banks when credit markets allocate inefficiently due to screening costs.

the impact of size on credit restrictions has been mixed in Brazil, as observed in Terra (2003) and Aldrighi and Bisinha (2010), our results are in line with the traditional literature: cash flow coefficient is insignificant or at least (depending on the econometric specification) has a lower elasticity magnitude for larger firms.

Our two other categories, firms listed on the Brazilian stock market (public versus non-public firms) and level of export-to-sales ratio (no export at all, below and above the median) provide evidence that investments for firms listed on stock markets and for those large exporters are not sensitive to cash flow variation. Besides, the influence of these categories is beyond any possible correlation with size. When interacting those dummies, listed and export, with size groups, our results suggest that while non-large firms are in general credit constrained, this credit restriction was softened for listed firms and large exporters.

The above results are particularly interesting for the design of public policy. An institutional feature of Brazil is the existence of a development bank (BNDES) that provides funding to investment projects and, as such, tries to relieve credit constraints. Indeed, after the 2008′s international financial crisis BNDES's budget increased substantially. But, as there is a wedge between raising and lending interest rates, financial support by the bank is costly, and so it is important to direct resources for firms that are most credit constrained. Our main results, in this regard, suggest that small/medium, non listed firms with no exports receipts should be the priority target for subsidized credit. Besides that, policy design may reach a level beyond credit concession, since as larger, exporting, and listed firms are less prone to suffer from credit constraints, policies that stimulate firms' access to foreign markets or to foster capital markets are desirable in order to increase investments.

In order to perform our investigation, this paper is structured in 5 sections apart from this introduction. Section 2 provides a brief survey of the literature. Section 3 presents methodology to analyze credit restriction. Data description is presented in Section 4 as well as some descriptive statistics on the main variables. Next, we present and discuss our results, followed by robustness outcomes. Last section concludes.

2. Relation to the literature and the Brazilian context

In a world of perfect capital markets, without transaction costs and taxes, the Modigliani–Miller Theorem asserts that financial structure of firms is irrelevant for their real decisions, in particular investments. But in reality all these assumptions are non-valid, and a special focus of the literature has been on the case of asymmetric information. The asymmetries in financial markets may be due to differential information about types, where borrowers have more information about their projects' risks or managerial abilities than creditors, or due to difficult verifiability of actions, where creditors cannot observe investment choices or the real capacity of repayment from borrowers. The main consequence is a gap between the internal (for example, retained profits) and external (for example, bank credit) cost of funds, explained by the creditor's need to raise funds to compensate risk of bad quality borrowers (the adverse selection problem) or costly monitoring (the moral hazard problem) (Stiglitz and Weiss, 1981).

An empirical testable implication of higher costs from external sources is that increases in firms' cash flow must lead to more investment. Moreover, as supposed by a major part of the literature, another implication should be a more sensitive correlation between cash flow and investment in firms where information costs (and hence the gap between the internal and external costs of funds) are higher.

The seminal researchers testing these hypotheses were Fazzari et al. (1988). They split a sample of US firms into three categories regarding dividend payments, high, medium and low, and showed that the relation between cash flows and investments was significantly higher in the last group, which corroborates the hypothesis when one assumes that these kinds of firms are more likely to suffer credit restrictions.

This paper led to an extensive empirical literature, where two main themes have been emphasized: the need to control in an appropriate manner for investment opportunities, where otherwise a positive association between cash flow and investment may simply say that better opportunities induce firms' investment and at the same time impact cash today, and a critic of the basic methodology employed in FHP regarding the criteria for splitting the firms into different classes of information costs.

Concerning the first problem, the initial proxy used for controlling investment opportunities, Tobin's Q, was criticized because what can be constructed using real data (mean Q) is equivalent to what in theory reflects investments opportunities (marginal Q) only under strong assumptions. Moreover, Tobin's Q, as the ratio between firm market value and recomposition cost of capital, only reflects investment opportunities from an outside point of view, which

may not properly capture real opportunities under imperfect capital markets (Carpenter and Guariglia, 2008). Besides, this proxy is simply absent when one analyzes data with non-traded firms (Baun et al., 2011; Guariglia et al., 2011).

The response to this problem has been mixed in the literature, ranging from the development of alternative proxies that can better capture investment opportunities to a change in methodology that abandons the necessity of using Tobin's Q. For the first approach, prospect of future expense in capital goods is used to complement information in Tobin's Q in order to capture the internal view of opportunities (Carpenter and Guariglia, 2008), or more aggregate variables are used in this regard, as industry-level value-added growth when data base contains firms not traded publicly (Guariglia et al., 2011). For the second, it is better exemplified by the "Euler equation approach" to the problem, where one tests if the firms' investment behavior is consistent with the first-order condition that may prevail when they solve a dynamic programming problem under perfect markets (Bond and Meghir, 1994). Although many of these proposed solutions may be ingenious, finding a proper control is a challenging task. Most studies are subject to the criticism that a statistically positive correlation between cash flow and investment may reflect mismeasured investment opportunities.

Another challenge to this literature is given by how to classify firms with regards to to levels of information costs. In an influential paper, Kaplan and Zingales (1997) argued that theoretically the relation between the dependence of investments to internal funds and information costs was not necessarily monotonic. They reviewed the seminal article of FHP, and splitting their low dividend payment sample with respect to the probability of liquidity need, they showed that the relation between cash flow and investment was weaker in firms facing liquidity constraints, which was a contradiction to the hypothesis sustained by FHP. Moreover, KZ raised an interesting insight regarding whether this result is at odds in the literature, because the financial criteria used to classify firms according to their level of credit restriction in main papers may not correspond to the real information cost and hence effective credit constraints faced by these firms. For instance, firms linked to a bank (conglomerates) may be less credit constrained under an adverse selection story since "lemons risk" limits access to capital markets to those not linked to the conglomerates.

KZ paper was the origin of a huge controversy in this literature, with some authors reaffirming KZ findings (Cleary, 1999) while others criticizing their approach (for instance, Hubbard (1998) or Allayannis and Mozumdar, 2004). One of the main arguments against KZ is that firms classified as most prone to suffer illiquidity are in general financially distressed, where creditors may seize their new generated funds as repayment for old debts, weakening in this way the relationship cash flow to investment. Beyond this controversy, a point that must warn researchers refers to the proper classification of firms by categories that really measure information costs. In fact, Cleary et al. (2007) argues that the sensitivity of cash flow to investment between firms with more or less financial restriction depends crucially on what variables are used to classify firms as credit constrained.

The relation between investment and cashflow was already studied in Brazil. In fact, the structure of Brazilian capital markets is suggestive that firms may be subject to credit constraints. On the one hand, while the banking system is considered robust and sophisticated, the segment of long term credit is a point of weakness, being covered almost exclusively by state-owned institutions. The market for corporate bonds is incipient, due, for instance, to the difficulty of developing a secondary market that may provide liquidity for potential investors. On the other hand, the stock market is relatively well developed, but only a few firms have access to it.

Terra (2003) is one of the main references in the Brazilian literature. More recently, we can cite the work of Aldrighi and Bisinha (2010). The general conclusion of these authors is that Brazilian firms are indeed credit-constrained. However, at odds with the conventional literature, firms that should be more credit constrained when using some standard measure (size, for instance) do not appear to have a more significant coefficient in the investment — cash flow equation. In Terra (2003), the hypothesis that the cash flow coefficient is equal for large and small firms cannot be rejected, unless in a limited period of time (1994–1997) when credit constraints were softer among large firms.[2] In Aldrighi and Bisinha (2010), the cash flow coefficient is always significant, and indeed increases with firm size. The authors suggest that financial difficulties between firms with smaller size may explain their findings, as the desire to maintain a "financial slack", avoiding in this way future liquidity problems, may weaken the investment – cash flow relationship.

A main feature of both papers is that they use information of firms which are required by law to make their balance sheet data public, since their shares are available on the stock market. As mentioned in the introduction, we contribute to this literature by analyzing also firms not listed in the stock market, which correspond to the major part of Brazilian

[2] Indeed, the country experienced large inflows of FDI due to the privatization program in this period.

firms. And for the two main concerns of the literature cited previously, our paper controls for investment opportunities using variables at the firm, as well as at the sectorial level. Furthermore, regarding the classification of firms within different information costs, we believe that the categories we use-size, access to capital markets, and export capacity-can properly measure credit constraints.

3. Methodology

The model to investigate whether Brazilians firms are credit constrained is based on Carpenter and Guariglia (2008) and Guariglia (2008), as shown in (1).

$$I_{it}/K_{it-1} = \delta\,(Cash\,Flow_{it}/K_{it-1}) + \beta' X_{it} + \gamma_t + \mu_i + \varepsilon_{it} \tag{1}$$

where i and $t = 1,\ldots,T$ identify, respectively, firms and time, I_{it} is the firms' investment, K_{it} is the firms' fixed asset, γ_{t} is the time-effect for controlling business-cycle effects, μ_i is the firms' fixed-effect, and ε_{it} is the error-term. For robustness checks, the specification (1) may include covariates X_{it}, given by investment opportunities variables, which also impact the dependent variable.

For eliminating time invariant unobservables firms' characteristics, we estimate Eq. (1) by fixed-effect and first-difference. Time-effect is controlled by imposing dummies for instant t.

The OLS in first-difference may present problems of endogeneity associated to a reverse causality between firms' investment and cash flow. Ideally, an exogenous instrument which can only affect investment through cash flow would be able to address this issue effectively. However, papers in this literature fail to provide a completely exogenous instrument to address the endogeneity. Due to this fact, we apply Generalized Method of Moments approach (GMM) based on the structure of instrumental variables of Arellano and Bover (1995) and Blundell and Bond (1998), as they represent most current strategy to address this shortcoming, since it has been used in the recent literature, see Guariglia et al. (2011) as an example. This approach combines the standard set of equations in first-difference with lagged levels of regressors as instruments with the incorporation of equations in levels with lagged first-difference as instruments.

In this case, we assume that actual cash flow shocks do not influence future realization of the error term; therefore cash flow is considered an exogenous variable. The same assumption is considered for covariates. First-difference equation includes all regressors lagged twice as instruments. It means that we assume the moment restrictions where $Cash\ Flow_{it\text{-}2}/K_{\mathrm{it\text{-}3}}$ is not correlated to $(\varepsilon_{\mathrm{it}} - \varepsilon_{\mathrm{it\text{-}1}})$.

Following Blundell and Bond (1998), we also incorporate an additional moment restriction to GMM estimations. As we have only instruments lagged twice for the level equation and given our limited number of years in the database ($T = 3$), we also incorporate equations in levels with lagged first-difference instruments to the system. The estimation, which includes additional moment condition proposed by Blundell and Bond (1998), is called system-GMM or SYS-GMM. In this case, our assumption requires that $\varepsilon_{\mathrm{it}}$ is not correlated to $(Cash\ Flow_{it\text{-}1}/K_{\mathrm{it\text{-}2}} - Cash\ Flow_{it\text{-}2}/K_{\mathrm{it\text{-}3}})$.

The addition of another moment restriction is crucial when the lagged level of the series in the first-differenced equation is weakly correlated to explanatory variable. Thus, instruments are weak yielding biased estimators.

The consistency of system GMM estimators depends on the validity of instruments, i.e., it is necessary that instruments satisfy the orthogonal condition. In the empirical literature of system GMM approach, papers evaluate this aspect by applying Sargan test of overidentifying restriction (j-test), which tests the validity of orthogonal conditions.

Notice, however, that although j-test may be important for instrument validation, our assumption on the exogeneity of cash flow is feasible in the context of the relationship of explanatory variables and firms' investment. It is possible that actual cash flow may impact directly actual and future firms' investment decision, but it is less probable that actual cash flow may impact future shocks of investment.

The parameter of interest is $\hat{\delta}$. In the presence of imperfection in credit market, the estimated coefficient $\hat{\delta}$ should be positive and statistically significant, i.e., the firms' investment is sensitive to the cash flow, as discussed previously.

However, as mentioned before, the relationship between cash flow and investment may be merely a consequence of a firms' perspective about its future profitability captured by internal view of opportunities. In the absence of investment opportunities as control variables, the cash flow coefficient $\hat{\delta}$ is biased even after solving endogeneity problems.

Given the inexistence of market value for all firms in our database, we account for investment opportunity by two different types of proxies. Following the empirical literature, in terms of covariate, we control for variables that capture investment opportunity in sectorial and firms' level. In sectorial terms, as suggested by Carpenter and Guariglia (2008), we include the actual impact of industry-level of value-added growth. We also incorporate industry-level investment

growth. We believe that the dynamic of sectorial investment may influence directly the business decision to invest. At the firms' level, we add sales growth considering the Euler equation approach of Bond and Meghir (1994) as discussed in Section 2.

Although the main aim of the paper is to evaluate whether Brazilian manufacturing firms are credit constrained, we also investigate whether there are differences in the cash flow coefficient across the following groups of firms: (i) by size, evaluated by number of employees; (ii) whether they are listed or not on the stock market; and (iii) the level of firms' exports, given by the ratio between exports and sales revenue. All these classifications allow coefficients of control variables to differ across observations in the distinct sub-samples and it will indicate the level of financial constraints faced by firms. Thus, cash flow variable may be interacted with different dummies variables:

a) $SMALL_{it}$ refers to the firms i that have a number of employees inferior than the its 25th percentile of the sample distribution at instant t, $MIDDLE_{it}$ indicates the number of employees between 25th and 75th percentile, and $LARGE_{it}$ refers to the number of employees which fall above the 75th percentile.
b) $LISTED_{it}$ refers to firm i listed on the Brazilian stock market[3] in the period between 2007 and 2010, and $NOT\ LISTED_{it}$ the opposite.
c) NO_{it} indicates non-exporting firm i at the instant t, LOW_{it} refers to exporting firms but with $Exports_{it}/Sales_{it}$ which falls below the 50th percentile of the sample distribution, and $HIGH_{it}$ indicates the opposite.

4. Data and summary statistics

In order to evaluate the link between cash flow and investment, we use four different sources. SERASA is the main source as it contains balance sheet information for more than 28 thousand Brazilian firms with annual revenue over R$ 10 million (around US$ 3 million).[4] SERASA is a company that compiles firms' financial statements and analyzes these information to create credit scores. In summary, SERASA dataset comprehends the information of all active firms in Brazil which are able to collect information.[5] From this dataset, we use different measures: capital, investment, cash flow and sale's revenue. Capital is the fixed assets value of each firm and investment is its variation. Cash flow is measured by Earnings Before Interest, Tax, Depreciation and Amortization (EBITDA). The dataset comprehends all sectors of the economy from 2006 to 2010, yet focus here will be given to manufacturing sector from 2007 to 2010.

There are two reasons for this restriction. First, investment opportunities data is only available for the manufacturing sector between 2007 and 2010. Basically, sectorial investment opportunities variables are given by the industry-level value added growth as well as the industry-level of fixed asset growth. These two variables are obtained from PIA-IBGE database (Brazilian Annual Survey of Industry). Second, manufacturing firm level data for 2006 is limited, containing fewer than 1000 firms. It is different from the period 2007–2010, in which more than 3000 manufacturing firms exist per year. Therefore, we focused on firm-level data starting in 2007 in order to keep cross-section information as wide as possible.

Two other sources are utilized for this investigation. Number of employees of each firm from the Annual Social Information Report (*Relação Anual de Informações Sociais* — [RAIS]) of the Ministry of Labor is used to control for size. Additionally, information of the Foreign Trade Secretary (*Secretaria de Comércio Exterior* — [SECEX]) of the Ministry of Industrial Development and Foreign Trade regarding how much each firm has exported is considered.

To control for potential influence of outliers, we exclude firms with observations in the one percentile of each investment and cash flow variables. Finally, if firms' information is missing in any year from the period, we dropped it. Our final data consist of a balanced panel with 3343 firms related to all manufacturing sectors. We divide our sample in three ways: listed on the Brazilian stock market (Listed); and large firms compared to Small and Medium Enterprises (SME); and their export status. This dataset covers 27% of total revenues and 43% of total employment in the manufacturing sector.[6] Furthermore, it is important to emphasize that SERASA database consists mainly in non-listed firms, covering a huge range of size. In this way, our study appears more suited for an investigation of

[3] Brazilian stock exchange market is named *Bolsa de Valores*, *Mercadorias* & *Futuros de São Paulo* (BMF&BOVESPA).
[4] For more information on SERASA spectrum, please see either Oliveira (2012) or https://www.serasaexperian.com.br/.
[5] Nevertheless, the 28 thousand firms from our initial sample are a random selection of the total SERASA database.
[6] For 2010 figures.

Table 1
Descriptives statistics — mean 2008–2010.

Variables	All	Large	SME	Listed	Not listed	No exp	Exp low	Exp high
Investment/capital	0.24	0.25	0.24	0.26	0.24	0.27	0.23	0.19
Cash Flow/capital	0.94	0.63	1.05	0.44	0.95	0.99	1.05	0.75
Employees	416	1247	144	4776	380	376	455	492
Export/Sales (%)	6%	8%	6%	4%	6%	0%	1%	23%
Number of obs.	10,029	2562	7466	105	9924	4900	2626	2502

credit restrictions than the ones focused on firms listed on stock markets, which are larger than the average firms in a developing country, like Brazil. Additionally, it is worth to mention that there are correct incentives for firms to provide true information to SERASA, because this information may be disclosed to the banking system and contributing to potential access to credit in more favorable conditions.

As seen in Table 1, the majority of firms in our sample are not listed on the stock market as well as they are SME. Firms in our sample have around 416 employees where their exports represent only 6% of their revenues. Overall, figures represent what is expected: Firms listed on the stock market are larger expressed by the number of employees. Regarding investment over capital, Brazilian firms in the manufacturing sector invest around a quarter of its capital every year. Moreover, there is no large difference between them, even when considering among the three categories defined above. What is striking is that firms not listed on the Brazilian stock market, SME and low exporters generate on average cash flow around their capital stock. Moreover, large firms generate only 63% cash flow compared to its capital, public-listed firms generate 44% and high exporters, 75%.

In summary, considering these descriptive statistics, we may infer that SME firms, for instance, might be credit restricted since they have to generate much more cash flow in order to invest at the same rate as large firms. The same interpretation might be done for those not listed on the stock market. An important difference emerges in export status. Investment rate in large exporters is lower than non-exporters or those exporting below the median. However, their capacity to generate funds is lower than those other two groups. In other words, it seems that being a large exporter enables them to be less restricted. All these outcomes are rough evidences which should be corroborated by econometric scrutiny.

5. Empirical results

Our results from specification (1) are presented in Table 2. Using data from 2008 to 2010,[7] three approaches are explored: pooled ordinary least square (OLS); within groups (WG); and SYS-GMM. In the case of GMM approach, instruments are available for 2008 in the case of equation in first difference and 2009 and 2008 for level equation.

As said before two variables are applied as covariates in order to capture the sectorial investment opportunities effect: the industry-level of value added growth $VA\ Growth_{jt}$ and the industry-level of investment growth $Inv\ Growth_{jt}$. At the firm level, we impose the firms' annual sales growth variable $Sales\ Growth_{it}$ in order to control also for investment opportunities. Time dummies and industry dummies interacted with time dummies were included in all the specification.

All estimated models have evidenced that firms are credit constrained even after controlling by industry-level variables. However, cash flow coefficients estimated by GMM have a superior impact when compared to other methods. This result may indicate that within groups estimates may still suffer from endogeneity bias. Notice that Sargan tests reveal that lagged explanatory variables are valid instruments for both system-GMM regressions given that we do not reject the null hypothesis that overidentifying restrictions are valid. As discussed in Section 3, $Cash\ Flow_{it\text{-}1}/K_{it\text{-}2}$ may also be an additional explanatory variable for explaining firms' investment. It is possible that previous cash flow may impact directly actual and future firms' investment decision. At first moment, we did not include lag values of cash flow in Eq. (1) because our database has an insufficient number of years ($T = 3$) for satisfying system GMM moment restriction. However, as an alternative for the absence of cash flow lagged values as instruments for the additional

[7] Investment is measured by the differences between two years of fixed asset. Thus, we are able to construct investment only for 2008–2010.

Table 2
The effects of firms' cash flow on investment.

	Pooled OLS		WG		SYS-GMM	
	(1)	(2)	(3)	(4)	(5)	(6)
$Cash\ Flow_{it}/K_{it\text{-}1}$	0.06***	0.06***	0.13***	0.13***	0.26***	0.25*
	(0.01)	(0.01)	(0.02)	(0.02)	(0.08)	(0.14)
$Sales\ Growth_{it}$		0.14***		−0.01		0.11
		(0.02)		(0.03)		(0.43)
$VA\ Growth_{jt}$		0.06		−0.14*		0.01
		(0.08)		(0.08)		(0.07)
$Inv\ Growth_{jt}$		0.03***		−0.01		−0.04
		(0.01)		(0.01)		(0.19)
Sample size	6686	6686	6686	6686	10,029	10,029
j-statistic (p-value)					0.97	0.57

Notes: Robust standard errors are reported in parentheses, *j-statistic* refers to Sargan test of the overidentifying restrictions.
* indicates significance at the 10% level and *** 1%.
Instruments for the model estimated by system GMM in column (5) are $Cash\ Flow_{it\text{-}2}/K_{it\text{-}3}$ for first-difference equation and $\Delta(Cash\ Flow_{it\text{-}1}/K_{it\text{-}2})$ for level equation. Instruments of model in column (6) are $Cash\ Flow_{it\text{-}2}/K_{it\text{-}3}$, $Sales\ growth_{it\text{-}2}$, $VA\ growth_{jt\text{-}2}$ and $Inv\ growth_{jt\text{-}2}$ for first-difference equation and $\Delta(Cash\ Flow_{it\text{-}1}/K_{it\text{-}2})$, $\Delta(Sales\ growth_{it\text{-}1})$, $\Delta(VA\ growth_{jt\text{-}1})$ and $\Delta(Inv\ growth_{jt\text{-}1})$ for level equation.
Time dummies and time dummies interacted with industry dummies were included in all the specification and also in the standard instruments sets of first-difference equation in the case of SYS-GMM models.

explanatory variable $Cash\ Flow_{it\text{-}1}/K_{it\text{-}2}$, we include a moment condition in the level equation based on both lagged sectorial variables and firms' variables. In the system GMM regression, the coefficient of Cash flow in $t-1$ is not significant at conventional levels and it does not interfere in the results of current cash flow. The choice of instruments is based on the Sargan test.[8]

Both sales and industry investment growth are only significant for pooled OLS estimates. Controlling for firm-effect, value added growth became statistically significant at the 10% level, nonetheless, with a wrong signal. Basically covariate coefficients do not affect the impact of cash flow in the system GMM regression.

Considering all these aspects, model 6 reveals an estimated coefficient equal to 0.25. Evaluated at the sample mean, this indicates an elasticity of the cash flow to capital ratio correspondent to 0.98. Indeed, this is a striking result: the impact of cash flow on investment is practically equivalent to the unity; in other words, for every increase in cash flow, investments raise at same magnitude. For instance, Carpenter and Guariglia (2008) findings suggest an elasticity of 0.16 for the UK. In other words, credit constraints in Brazil during the investigated period were more than 6 times what was observed in a developed country. These findings suggest that firms in developing countries are indeed more credit constrained than those in the developed world.

However, the impact of cash flow and investment opportunities variables on investment may be different among firms given the degree of credit constraint. In this sense we evaluate the impact of cash flow on investment by classifying firms according to categories that may properly proxy for the degree of credit constraint. The first category considered is the firms' size, as shown in the first part of Table 3. Due to the fact that pooled OLS and within group coefficient may suffer from endogeneity problem, all models from now on are estimated by system GMM.[9]

The first part of Table 3 is structured as follows: first model presents results without controls; the second model has controls but they are not classified by firms' size; the third model shows results where only sectorial controls are divided according to firms' size; last model presents outcomes where all controls are classified by firms' size.[10] In all regressions, lagged instruments follow the same group categorization of explanatory variables as pointed out in table's notes. Notice that Sargan test reveals again that this type of instruments remains valid in all models.

[8] Results are shown in Table A1 of Appendix A.
[9] For observing the effect of instrumental variable strategy over our findings, we also present the within group regressions of model 4 - Table 3 in Table A2 of Appendix A.
[10] All tables from now on follow this structure of group categorization.

Table 3
System GMM estimation of the effects of firms' cash flow on investment classified by size and by export-sales ratio groups.

Size groups (A)	(1)			(2)				(3)				(4)		
	Small	Medium	Large	Small	Medium	Large	Not categorized	Small	Medium	Large	Not categorized	Small	Medium	Large
$Cash\ Flow_{it}/K_{it\text{-}1}$	0.30***	0.14**	0.36***	0.22**	0.11**	0.31**		0.15***	0.12**	0.12		0.11**	0.10**	0.12
	(0.10)	(0.05)	(0.12)	(0.11)	(0.05)	(0.14)		(0.05)	(0.05)	(0.09)		(0.04)	(0.04)	(0.11)
$Sales\ Growth_{it}$							No				Yes	No	Yes	Yes
$VA\ Growth_{jt}$							No	Yes	No	No		Yes	No	No
$Inv\ Growth_{jt}$							No	No	Yes	No		No	No	No
$H_0{:}\delta^{small} = \delta^{middle}$		0.26			0.37				0.33				0.48	
$H_0{:}\delta^{middle} = \delta^{large}$		0.13			0.17				0.04				0.005	
$H_0{:}\delta^{small} = \delta^{large}$		0.71			0.54				0.01				0.03	
Sample size		10,029			10,029				10,029				10,029	
j-statistic (p-value)		0.26			0.37				0.63				0.36	

Export-sales ratio groups (B)	No	Low	High	No	Low	High	Not categorized	No	Low	High	Not categorized	No	Low	High
$Cash\ Flow_{it}/K_{it\text{-}1}$	0.22***	0.12**	0.21*	0.13**	0.07*	0.16		0.15**	0.07*	0.14		0.14***	0.08**	0.14
	(0.06)	(0.05)	(0.12)	(0.06)	(0.04)	(0.11)		(0.05)	(0.04)	(0.10)		(0.05)	(0.04)	(0.09)
$Sales\ Growth_{it}$							Yes				Yes	Yes	No	Yes
$VA\ Growth_{jt}$							No	No	No	No		No	No	No
$Inv\ Growth_{jt}$							Yes	Yes	No	Yes		No	No	Yes
$H_0{:}\delta^{no} = \delta^{small}$		0.29			0.32				0.22				0.24	
$H_0{:}\delta^{small} = \delta^{high}$		0.53			0.09				0.10				0.06	
$H_0{:}\delta^{no} = \delta^{large}$		0.94			0.06				0.01				0.01	
Sample size		10,029			10,029				10,029				10,029	
j-statistic (p-value)		0.03			0.36				0.80				0.35	

Notes: Robust standard errors are reported in parentheses, *j-statistic* refers to Sargan test of the overidentifying restrictions.
YES indicates significance at 10% level of estimated covariate coefficients and NO indicates a non-significant coefficient. Not categorized indicates that covariates are not categorized by the level of credit constraint faced by firms.
* indicates significance at the 10% level, ** 5%, *** 1%. The tests that assess whether estimated coefficients are equal across groups also include a second restriction regarding the cash flow as null for the large group in models (3) and (4) of Part A and the group of high exporting firms in models (2)–(4) of Part B.
The instruments for estimated model by system GMM in model (1) are $[Cash\ Flow_{it\text{-}2}/K_{it\text{-}3}] \times Categories_{t\text{-}2}$ for first-difference equation and $[\Delta(Cash\ Flow_{it\text{-}1}/K_{it\text{-}2})] \times Categories_{t\text{-}1}$ for level equation. Instruments of model (2) are $[Cash\ Flow_{it\text{-}2}/K_{it\text{-}3}] \times (Categories_{t\text{-}2})$, $Sales\ growth_{it\text{-}2}$, $VA\ growth_{jt\text{-}2}$ and $Inv\ growth_{jt\text{-}2}$ for the first-difference equation and $[\Delta(Cash\ Flow_{it\text{-}1}/K_{it\text{-}2})] \times (Categories_{t\text{-}1})$, $\Delta(Sales\ growth_{it\text{-}1})$, $\Delta(VA\ growth_{jt\text{-}1})$ and $\Delta(Inv\ growth_{jt\text{-}1})$ for the level equation.
The model (3) includes as instruments $[Cash\ Flow_{it\text{-}2}/K_{it\text{-}3}] \times (Categories_{t\text{-}2})$, $Sales\ growth_{it\text{-}2}$, $[VA\ growth_{jt\text{-}2}] \times (Categories_{t\text{-}2})$ and $[Inv\ growth_{jt\text{-}2}] \times (Categories_{t\text{-}2})$ for the first-difference equation and $[\Delta(Cash\ Flow_{it\text{-}1}/K_{it\text{-}2})] \times (Categories_{t\text{-}1})$, $\Delta(Sales\ growth_{it\text{-}1})$, $[\Delta(VA\ growth_{jt\text{-}1})] \times (Categories_{t\text{-}1})$ and $[\Delta(Inv\ growth_{jt\text{-}1})] \times (Categories_{t\text{-}1})$ for the level equation. The model (4) includes the instruments of model (3). However, $[Sales\ growth_{it\text{-}2}] \times (Categories_{t\text{-}2})$ instruments takes the place of $Sales\ growth_{it\text{-}2}$ for first-difference equation and $[\Delta(Sales\ growth_{it\text{-}1})] \times (Categories_{t\text{-}1})$ instruments takes the place of $\Delta(Sales\ growth_{it\text{-}1})$.
Time dummies and time dummies interacted with industry dummies have been included in the standard instruments sets of first-difference equation.

Models 1 and 2 indicate that all cash flow estimated coefficients are significant at the 10% level. In addition, it is not possible to reject the hypothesis that cash flow coefficients are equal across groups, according to the p-value of χ^2 test at the bottom of part A.

When covariates are also classified by size groups, as observed in models 3 and 4, the coefficients of cash flow for large firms become non-significant as a result of a significant and positive influence of sales growth variable.[11] One should note that the middle firms' investment is still sensitive to cash flow even with the fact that the sales growth coefficient is positive and significant. The elasticity associated to cash flow of middle firms, evaluated at the mean, reaches 0.37. Considering small firms, the cash flow impact on investment is reduced when investment opportunity variables are considered, such that, elasticity in Model 4 evaluated at the sample mean is 0.60. This reduction may be explained by the presence of positive and significant impact of industry value of added growth.

Given that in models 3 and 4 cash flow coefficient for large groups individually is not significant at conventional levels, the tests that assess whether estimated coefficients are equal across groups associated to these models also include an additional null hypothesis, i.e., $H_0 : \hat{\delta}^{LARGE} = 0$. As a result, the test indicates that estimated coefficient for large firms differs from the other categories. Otherwise, there is evidence that the impact of cash flow on investment is identical for small and middle firms.

When all variables are classified by size groups, we observed that investment opportunity variables have important information about firms' investment. This outcome is essential given that the lack of control of sales growth has led to a different conclusion about the degree of credit constraint for large firms.

Another way of evaluating the degree of credit constraint is classifying firms by their export to sales ratio, as presented in the part B of Table 3. As discussed before, export revenue may be seen as potential collateral; in this way, facilitating access to international financial markets and alleviating credit constraints.

With the exception of the first model, when firms have a large ratio of export over sales, the impact of cash flow on investment is null as a consequence of the significant effect of the control variables, specially, sales growth and industry-level of investment growth. On the other hand, financial constraint condition remains valid for both non-exporters and low-export firms.

Model 4 has an elasticity of cash flow on investment for non-exporters, evaluated at the sample mean, equal to 0.52, whereas elasticity for lower exporters is smaller (exactly 0.35). However, taking into account that the influence of cash flow on investment is not significant in the high-export group, the null hypothesis of the test that assumes that coefficients are equal across these groups is not rejected at the 10% level. In fact, only in the case of large exporters, it is possible to reject this hypothesis.

Comparing these outcomes with those related to the size classification, we can find some similarities. First, the proxy variables for investment opportunity are important to explain firms' investment. Furthermore, they alter the magnitude of cash flow coefficient associated to the groups with high level of credit constraint. The most important evidence is that without the presence of covariates, the cash flow is always significant even for the group with the lowest degree of credit constraint.[12]

Finally, the participation in the Brazilian stock market is the third way to evaluate the degree of firms' credit constraint. Table 4 presents regression outcomes splitting the sample into firms listed on the stock market or not listed.

In all models, it is not possible to verify a positive and significant impact of cash flow on investment for public firms. As discussed previously, 35 manufacturing firms available in SERASA database are listed on the stock market, yielding 105 observations from 2008 to 2010. Even after controlling for sales growth and investment opportunities, only non-listed firms reveal that credit is constrained. In this case, the elasticity, evaluated in the sample mean, is similar to GMM results of Table 2, given that the vast majority of firms compounding the database are not listed on the stock market.

Furthermore, when assessing whether estimated coefficients are equal across both groups, with the exception of model 1, the null hypothesis is not rejected at conventional level for three models, despite their isolated significance.

[11] In the case of within group regressions shown in the first part of Table A2, all cash flow estimated coefficients are significant at 10% level, including large firms. This result is valid even in models where covariates are also classified by firms' size. It indicates that the instrumental strategy proposed here based on lagged variables impact decisively our general outcomes.

[12] Once again according to the regression estimated by within group presented in Table A2 of Appendix A, our instrumental variable strategy impacts the relationship between cash flow and firms' investment for the group of high exporting firms. The within group cash flow coefficient for high-export firms is significant at 10%.

Table 4
System GMM estimation of the effects of firms' cash flow on investment classified by stock market participation.

Stock market participation groups	(1)		(2)			(3)			(4)	
	Listed	Not listed	Listed	Not listed	Not categorized	Listed	Not listed	Not categorized	Listed	Not listed
$Cash\ Flow_{it}/K_{it-1}$	−0.18	0.27***	−0.14	0.26*		0.09	0.24*		0.08	0.23*
	(0.36)	(0.08)	(0.32)	(0.14)		(0.17)	(0.13)		(0.16)	(0.13)
$Sales\ Growth_{it}$					No			No	No	No
$VA\ growth_{jt}$					No	No	No		No	No
$Inv\ growth_{jt}$					No	No	No		No	No
$H_0: \delta^{Listed} = \delta^{NotListed}$		0.002		0.18			0.16			0.18
Sample size		10.029		10.029						10.029
j-statistic (p-value)		0.38		0.44						0.79

Notes: robust standard errors are reported in parentheses, *j-statistic* refers to Sargan test of the overidentifying restrictions.
YES indicates significance at 10% level of estimated covariate coefficients and NO indicates a non-significant coefficient. Not categorized indicates that covariates are not categorized by the level of credit constraint faced by firms.
* indicates significance at the 10% level, ** 5%, *** 1%. The tests that assess whether estimated coefficients are equal across groups also include a second restriction regarding the cash flow for the group of listed firms as null.
The instruments for estimated model by system GMM in model (1) are $[Cash\ Flow_{it-2}/K_{it-3}] \times Categories_{t-2}$ for first-difference equation and $[\Delta(Cash\ Flow_{it-1}/K_{it-2})] \times Categories_{t-1}$ for level equation. Instruments of model (2) are $[Cash\ Flow_{it-2}/K_{it-3}] \times (Categories_{t-2})$, $Sales\ growth_{it-2}$, $VA\ growth_{jt-2}$ and $Inv\ growth_{jt-2}$ for the first-difference equation and $[\Delta(Cash\ Flow_{it-1}/K_{it-2})] \times (Categories_{t-1})$, $\Delta(Sales\ growth_{it-1})$, $\Delta(VA\ growth_{jt-1})$ and $\Delta(Inv\ growth_{jt-1})$ for the level equation. The model (3) includes as instruments $[Cash\ Flow_{it-2}/K_{it-3}] \times (Categories_{t-2})$, $Sales\ growth_{it-2}$, $[VA\ growth_{jt-2}] \times (Categories_{t-2})$ and $[Inv\ growth_{jt-2}] \times (Categories_{t-2})$ for the first-difference equation and $[\Delta(Cash\ Flow_{it-1}/K_{it-2})] \times (Categories_{t-1})$, $\Delta(Sales\ growth_{it-1})$, $[\Delta(VA\ growth_{jt-1})] \times (Categories_{t-1})$ and $[\Delta(Inv\ growth_{jt-1})] \times (Categories_{t-1})$ for the level equation. The model (4) includes the instruments of model (3). However, $[Sales\ growth_{it-2}] \times (Categories_{t-2})$ instruments takes the place of $Sales\ growth_{it-2}$ for first-difference equation and $[\Delta(Sales\ growth_{it-1})] \times (Categories_{t-1})$ instruments takes the place of $\Delta(Sales\ growth_{it-1})$.). Time dummies and time dummies interacted with industry dummies have been included in the standard instruments sets of first-difference equation.

6. Robustness checks

In our previous analysis, it is possible that listed firms on stock markets and their export shares on sales are really not size independent. Instead, larger firms tend to be over-represented in these two groups, such that, the credit constraint degree measured by these two classifications could be again an evaluation between large and non-large firms. To prevent this kind of effect, these groups (firms listed or not on the stock market and export's share) are interacted to groups of size.

Part A of Table 5 presents the estimated models considering four different firm groups created by the interaction between dummies of firms listed or not in stock market and size. As both small- and medium-sized firms have evidenced that cash flow coefficient is statistically equal across groups (see Table 3 outcomes), we reclassify them into large and non-large firms. The latter includes small and middle enterprises (SME). The main reason for this procedure is to create different financial constraint groups with sufficient number of observation. This is an important procedure given that there is only one small firm listed on the stock market while medium size firms equal eleven.

According to models 1–3, the estimated models continue to evidence that credit is constrained for unlisted firms. Considering the model 4, only the group of unlisted and non-large firms have evidenced that credit is constrained as a consequence of the significant and positive impact of the sales firms' growth variable. Hence, Brazilian firms listed on the stock market are not credit constrained and this condition is valid even for non-large firms. Associated to this result, with the exception of the model 2, the test that evaluate whether cash flow impact on investment are equal across non-large firms reveals that the null hypothesis is rejected.

In general, size classification does not influence the general results about the relationship between cash flow and firms listed on the stock market. Regardless of size interaction, the investments of firms listed on BMF&BOVESPA are not sensitive to cash flow. In this sense, there is evidence that this classification is not capturing size effect. It seems a good proxy for the degree of firms' external financial constraint related to a type of domestic accessibility to credit resources. A possible explanation for this is related to the prerequisites to become a public company. Public firms must have independently audited balance sheets, protect minority shareholders, among other corporate governance issues. These restrictions provide a positive signaling to capital markets and might, therefore, help to alleviate credit constraints.

Table 5
System GMM estimation of the effects of firms' cashflow on investment classified by size, export-sales ratio and stock market participation.

Listed groups (A)	(1)				(2)					(3)					(4)			
Size groups	Listed		Not listed		Listed		Not listed		Not categorized	Listed		Not listed		Not categorized	Listed		Not listed	
	No large	Large	No large	Large	No large	Large	No large	Large		No large	Large	No large	Large		No large	Large	No large	Large
$Cash\ \ Flow_{it}/K_{it-1}$	−0.06	−0.27	0.24**	0.31**	−0.12	−0.25	0.17*	0.29**		0.18	0.16	0.16**	0.18*		0.11	0.16	0.15**	0.10
	(0.30)	(0.57)	(0.08)	(0.14)	(0.29)	(0.47)	(0.10)	(0.14)		(0.26)	(0.11)	(0.06)	(0.10)		(0.36)	(0.13)	(0.06)	(0.12)
$Sales\ \ growth_{it}$									No					No	No	No	No	Yes
$VA\ \ growth_{jt}$									No	No	Yes	No	No		No	No	Yes	No
$Inv\ \ growth_{jt}$									No	No	No	No	No		No	No	No	No
$H_0{:}\delta^{Listed} = \delta^{NotListed}$ (*no large*)		0.03					0.37				0.01					0.05		
$H_0{:}\delta^{Listed} = \delta^{NotListed}$ (*large*)		0.12					0.13				0.15					0.55		
Sample size		10.029					10.029				10.029					10.029		
j-statistic (p-value)		0.33					0.48				0.66					0.51		

Export-sales ratio groups (B)	High		Not high		High		Not high		Not categorized	High		Not high		Not categorized	High		Not high	
Size groups	No large	Large	No large	Large	No large	Large	No large	Large		No large	Large	No large	Large		No large	Large	No large	Large
$Cash\ \ Flow_{it}/K_{it-1}$	0.17	0.26*	0.20**	0.33*	0.14	0.18	0.08	0.26		0.12	0.18	0.12**	0.20*		0.11	0.15	0.16**	0.23*
	(0.12)	(0.15)	(0.06)	(0.17)	(0.11)	(0.14)	(0.07)	(0.17)		(0.09)	(0.12)	(0.04)	(0.10)		(0.08)	(0.14)	(0.04)	(0.13)
$Sales\ \ growth_{it}$									Yes					Yes	No	No	No	No
$VA\ \ growth_{jt}$									No	No	No	No	No		No	No	No	No
$Inv\ \ growth_{jt}$									Yes	No	Yes	No	No		No	Yes	No	No
$H_0{:}\delta^{High} = \delta^{NotHigh}$ (*no large*)		0.000				0.159					0.029					0.003		
$H_0{:}\delta^{High} = \delta^{NotHigh}$ (*large*)		0.018				0.148					0.056					0.101		
Sample size		10.029				10.029					10.029					10.029		
j-statistic (p-value)		0.04				0.45					0.73					0.83		

Notes: robust standard errors are reported in parentheses, *j-statistic* refers to Sargan test of the overidentifying restrictions.
YES indicates significance at 10% level of estimated covariate coefficients and NO indicates a non-significant coefficient. Not categorized indicates that covariates are not categorized by the level of credit constraint faced by firms. * indicates significance at 10% level and ** 5%. No large firms group includes small and medium groups. In the tests that assess whether estimated coefficients are equal across groups also include more additional restrictions regarding the coefficients that are not significant at conventional levels as null.
The instruments for estimated model by system GMM in model (1) are $[Cash\ Flow_{it\text{-}2}/K_{it\text{-}3}] \times Categories_{t\text{-}2}$ for first-difference equation and $[\Delta(Cash\ Flow_{it\text{-}1}/K_{it\text{-}2})] \times Categories_{t\text{-}1}$ for level equation. Instruments of model (2) are $[Cash\ Flow_{it\text{-}2}/K_{it\text{-}3}] \times (Categories_{t\text{-}2})$, $Sales\ growth_{it\text{-}2}$, $VA\ growth_{jt\text{-}2}$ and $Inv\ growth_{jt\text{-}2}$ for the first-difference equation and $[\Delta(Cash\ Flow_{it\text{-}1}/K_{it\text{-}2})] \times (Categories_{t\text{-}1})$, $\Delta(Sales\ growth_{it\text{-}1})$, $\Delta(VA\ growth_{jt\text{-}1})$ and $\Delta(Inv\ growth_{jt\text{-}1})$ for the level equation. The model (3) includes as instruments $[Cash\ Flow_{it\text{-}2}/K_{it\text{-}3}] \times (Categories_{t\text{-}2})$, $Sales\ growth_{it\text{-}2}$, $[VA\ growth_{jt\text{-}2}] \times (Categories_{t\text{-}2})$ and $[Inv\ growth_{jt\text{-}2}] \times (Categories_{t\text{-}2})$ for the first-difference equation and $[\Delta(Cash\ Flow_{it\text{-}1}/K_{it\text{-}2})] \times (Categories_{t\text{-}1})$, $\Delta(Sales\ growth_{it\text{-}1})$, $[\Delta(VA\ growth_{jt\text{-}1})] \times (Categories_{t\text{-}1})$ and $[\Delta(Inv\ growth_{jt\text{-}1})] \times (Categories_{t\text{-}1})$ for the level equation. The model (4) includes the instruments of model (3). However, $[Sales\ growth_{it\text{-}2}] \times (Categories_{t\text{-}2})$ instruments takes the place of $Sales\ growth_{it\text{-}2}$ for first-difference equation and $[\Delta(Sales\ growth_{it\text{-}1})] \times (Categories_{t\text{-}1})$ instruments takes the place of $\Delta(Sales\ growth_{it\text{-}1})$. Time dummies and time dummies interacted with industry dummies have been included in the standard instruments sets of first-difference equation.

Furthermore, it is important to point out that, in model 4 the elasticity for unlisted and non-large firms, evaluated at sample mean, is 0.66, i.e., the impact of 1.0% in cash flow implies an increase of 0.66% in investment, similar to the elasticity of small firms groups in regressions of Table 2. Moreover, the coefficient of value added growth for non-large and unlisted firms is positive and significant. Nevertheless, opportunity investment information does not affect the significance of cash flow on firms' investment.

Part B of Table 5 reports the outcomes related to the models where variables are classified by firms' size and by the firms' degree of exports to sales ratio, together. One should note that, as shown in Table 3, both non-exporters as well as low-export firms are credit constrained and coefficients associated to them are statistically equal across the two groups. In this sense, we reclassify them into the following groups: no high group referring to firms with exports-to-sales ratio which falls below the 50th percentile of the exports-to-sales ratio distribution and high group indicates the opposite.

Considering the same export group, with the exception of model 2, firms' size does not influence the impact of cash flow on investment, especially when dummy interactions are extended to the control variables. Similarly to the general results of Table 3, the cash flow coefficient is null for large exporters. Focusing on firms with significant cash flow impact, i.e., the non-high exporters group (firms with zero or low export to ratio sales), there is not strong evidence that the coefficients across these two groups are different.

In this sense, interacting export groups to the firms' size do not affect the main results reported in Table 3. It suggests that export status proposed here does not capture size effect. Otherwise, as discussed, this classification may be associated to our perspective, i.e. the degree of firms' external financial constraint.

Finally, one caveat with the above analysis is that there are too few firms that are simultaneously listed on stock market and small, so comparison between public-listed versus unlisted small firms lacks robustness. Otherwise, results here are in line with those obtained when we interact size and export capacity, what give us more confidence is that the influence of both being listed on stock markets and export capacity are beyond any possible correlation with size: while in general non-large firms are credit-constrained, this restriction was softened for firms in this group who are listed on the stock market, or those that attained significant revenues from exports.

7. Conclusion

In this paper, we evaluate whether Brazilian manufacturing firms are credit constrained and which conditions prevail for the existence of credit restrictions. Our results back up previous important studies like Fazzari et al. (1988) as well as corroborate Brazilian studies, which also attest that firms are credit constrained (Terra, 2003 and Aldrighi and Bisinha, 2010).

Regarding results on firms' size, our findings are compatible with international literature (Guariglia, 2008), where credit constraints are softened or inexistent considering large firms. Otherwise, we also found that listed firms on the stock market are not credit constrained. Furthermore, the results also evidence that firms more devoted to exports, measured as the exports-to-sales ratio, are not credit constrained, whereas firms that do not export or have a low level of exports are credit constrained.

These are important findings given that both stock market participation and the level of export's sales may be seen as "domestic" and "foreign" source of external funds that eliminate the sensitiveness of investment to cash flow. It is also worthwhile to point out that all these results remain valid even when regressions are controlled by different investment opportunity proxies as well as when one considers the size's bias. That is to say, even small and middle firms that are public or high exporters do not experience credit restrictions, according to our outcomes.

Our findings in this paper may also have some valuable policy implications. In a developing country like Brazil, where capital is scarce and long-term credit is usually provided by state-owned banks, availability of other sources of funds are vital for accelerating economic growth. If we understand the stock market as an "inside" source of funds for firms in a country and export capacity as a proxy for "outside" source of funds, once export revenue may be seen as a collateral to get access to international financing, our results suggest that both were valuable for mitigating credit restrictions in Brazilian firms.

Of course, what our methodology strictly permits to investigate is a comparison of the levels of credit constraints among firms with certain characteristics (size, listed or not on the Brazilian stock markets and export capacity), and some hidden factors may determine both the degree of credit constraints and these characteristics. But, at the same time, our results show that the categories mentioned systematic reduced credit constraints for Brazilian firms, even after controlling for a series of observable variables that may impact the investment decision, reinforcing our suspicion

that there is indeed a casual effect. Whether this is the case, we can propose that government efforts should be made, for instance, to develop the stock market (or help firms to achieve the standards required to become public) and to stimulate exports, in this way contributing to alleviate credit constraints of domestic firms and sponsoring their investments.

In sum, it is feasible to emphasize that there is room for public policy implications considering our credit restriction results. Moreover, world economic situation after the economic crisis initiated in 2008 presents even more challenging scenarios for governments to address this market failure. Certainty is the importance of mitigating credit restriction for private firms to achieve more economic growth.

Appendix A.

Table A1
The actual and lagged effects of industry firms' cash flow on investment.

Dependent variable: I_{it}/K_{it-1}	Pooled OLS (1)	WG (2)	SYS-GMM (3)
$Cash\ \ Flow_{it}/K_{it-1}$	0.08***	0.15***	0.28***
	(0.01)	(0.02)	(0.06)
$Cash\ \ Flow_{it-1}/K_{it-2}$	0.04***	0.03***	−0.01
	(0.01)	(0.01)	(0.07)
Sample size	6686	6686	6.686
j-statistic (p-value)			0.88

Notes: robust standard errors are reported in parentheses, *j-statistic* refers to Sargan test of the overidentifying restrictions.
*** indicates significance at the 1% level.
Instruments for estimated model by system GMM in column (3) are $Cash\ Flow_{it\text{-}2}/K_{it\text{-}3}$ for first-difference equation and $\Delta(Cash\ Flow_{it\text{-}1}/K_{it\text{-}2})$, $\Delta(Sales\ growth_{it\text{-}1})$ and $\Delta(VA\ growth_{it\text{-}1})$ for level equation.

Table A2
Within Groups estimation of the effects of firms' cash flow on investment classified by size, export-sales ratio and stock market participation.

Size groups	Size groups			Export-sales ratio groups			Stock market participation groups	
	Small	Middle	Large	No	Small	High	Listed	Not listed
$Cash\ \ Flow_{it}/K_{it-1}$	0.12***	0.10***	0.23***	0.13***	0.12***	0.08***	0.24	0.12***
	(0.02)	(0.02)	(0.03)	(0.02)	(0.01)	(0.02)	(0.36)	(0.01)
$Sales\ \ growth_{it}$	No	No	No	Yes	No	Yes	No	No
$VA\ \ growth_{jt}$	No	No	No	No	No	No	No	No
$Inv\ \ growth_{jt}$	No	No	No	No	Yes	No	No	No
Sample size		10,029			10,029		10,029	
$H_0{:}\delta^{small} = \delta^{middle}$		0.36						
$H_0{:}\delta^{middle} = \delta^{large}$		0.00						
$H_0{:}\delta^{small} = \delta^{large}$		0.00						
	$H_0{:}\delta^{no} = \delta^{small}$				0.76			
	$H_0{:}\delta^{small} = \delta^{high}$				0.01			
	$H_0{:}\delta^{no} = \delta^{large}$				0.02			
		$H_0{:}\delta^{listed} = \delta^{notlisted}$			0.00			

Notes: robust standard errors are reported in parentheses, *j-statistic* refers to Sargan test of the overidentifying restrictions.
YES indicates significance at 10% level of estimated covariate coefficients and NO indicates a non-significant coefficient.
*** indicates significance at the 1% level.
For the stock market participation group model, the tests that assess whether estimated coefficients are equal across groups also include a second restriction regarding the cash flow for listed firms as null.
Time dummies and time dummies interacted with industry dummies have been included in all specifications.

Table A3
Within Groups estimation of the firms' cash flow on investment classified by export-sales ratio and stock market participation grouped by size.

Listed groups	(1)				(2)			
Size groups	Listed		Not listed		High		Not high	
	No large	Large	No large	Large	No large	Large	No large	Large
$Cash\ \ Flow_{it}/K_{it-1}$	−0.59	0.64*	0.11***	0.22**	0,07***	0,17***	0,11***	0,25***
	(0.38)	(0.37)	(0.01)	(0.03)	(0,02)	(0,04)	(0,01)	(0,03)
$Sales\ \ growth_{it}$	No	No	Yes	No	No	Yes	Yes	No
$VA\ \ growth_{jt}$	Yes	No	No	No	No	No	No	No
$Inv\ \ growth_{jt}$	No	No	No	No	No	No	No	No
Sample size		10.029					10.029	
$H_0{:}\delta^{Listed} = \delta^{Notlisted}$ (*no large firms*)	0.00							
$H_0{:}\delta^{Listed} = \delta^{Notlisted}$ (*large firms*)	0.25							
	$H_0{:}\delta^{High} = \delta^{NotHigh}$ (*no large firms*)				0.02			
	$H_0{:}\delta^{High} = \delta^{NotHigh}$ (*large firms*)				0.09			

Notes: robust standard errors are reported in parentheses, *j-statistic* refers to Sargan test of the overidentifying restrictions.
YES indicates significance at 10% level of estimated covariate coefficients and NO indicates a non-significant coefficient.
* indicates significance at the 10% level, ** 5%, *** 1%. For model 1, the tests that assess whether estimated coefficients are equal across groups also include a second restriction regarding the cash flow for listed and no large group as null.
Time dummies and time dummies interacted with industry dummies have been included in all specifications.

References

Allayannis, G., Mozumdar, A., 2004. The impact of negative cash flow and influential observations on investment-cash flow sensitivity estimates. J. Bank. Finance 28 (5), 901–930.
Aldrighi, D., Bisinha, R., 2010. Restrição financeira em empresas com ações negociadas na Bovespa. Rev. Bras. Econ. 64 (1), 25–47.
Arellano, M., Bover, O., 1995. Another look at the instrumental variable estimation of error-components models. J. Econom. 68 (1), 29–51.
Banerjee, A., Duflo, E., 2005. Growth theory through the lens of development. Economics Handbook of Economic Growth, vol. 1., pp. 473–552, Part A.
Banerjee, A.V., Duflo, E., 2014. Do firms want to borrow more? Testing credit constraints using a directed lending program. Rev. Econ. Stud. 81 (2), 572–607.
Baun, C.F., Schäfer, D., Talavera, O., 2011. The impact of the financial system's structure on firms' financial constraints. J. Int. Money Finance (30), 678–691.
Blundell, R., Bond, S., 1998. Initial conditions and moment restrictions in dynamic panel-data models. J. Econom. 87 (1), 115–143.
Bond, S., Meghir, C., 1994. Dynamic investment models and the firm's financial policy. Rev. Econ. Stud. 61 (2), 197–222.
Carpenter, R., Guariglia, A., 2008. Cash flow, investment, and investment opportunities: new tests using UK panel data. J. Bank. Finance 32 (9), 1894–1906.
CEMEC, 2016. Rentabilidade de títulos públicos inibe destinação da poupança para ações, títulos de divida corporativa e credito bancario. Nota CEMEC 04/2016.
Cleary, S., 1999. The relationship between firm investment and financial status. J. Finance 54 (2), 673–692.
Cleary, S., Povel, P., Raith, M., 2007. The U-shaped investment curve: theory and evidence. J. Financ. Quant. Anal. 42 (1), 1–39.
Eslava, M., Freixas, X., 2016. Public Development Banks and Credit Market Imperfections, Documento CEDE, (2016-06).
Fazzari, S., Hubbard, R., Petersen, B., 1988. Financing constraints and corporate investments. Brook. Pap. Econ. Act. 1, 141–206.
Guariglia, A., 2008. Internal financial constraints, external financial constraints, and investment choice: evidence from a panel of UK firms. J. Bank. Finance 32, 1795–1809.
Guariglia, A., Liu, X., Song, L., 2011. Internal finance and growth: microeconometric evidence on Chinese firms. J. Dev. Econ. 96 (1), 79–94.
Hubbard, G., 1998. Capital-market imperfections and investments. J. Econ. Lit. 36, 193–225.
Kaplan, S., Zingales, L., 1997. Do investment cash flow sensitivities provide useful measures of financing constraints? Q. J. Econ. 112 (1), 169–215.
Oliveira, F.N., 2012. The External Finance Premium in Brazil: empirical analyses using state space models. October, BACEN In: Working Paper Series, 295.
Stiglitz, J., Weiss, A., 1981. Credit rationing in markets with imperfect information. Am. Econ. Rev. 71 (3), 393–410.
Terra, M.C., 2003. Credit constraints in brazilian firms: evidence from panel data. Rev. Bras. Econ. 57 (2), 443–464.