Measuring Financial Restrictions of Brazilian Private Firms with Microdata: Did Credit Policies of Banco Central do Brasil During the Covid-19 Pandemic Affect Investment Demand?[*]

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Abstract

Our objectives in this paper are twofold. In the first place, we want to contribute to the literature by building new and original financial restriction measures of private firms. We use these measures to have an idea of financial restrictions of 5,664 private firms in Brazil from 2010 to 2020. To build these financial restriction measures, we use microdata of 1,316,455 loan contracts written between these firms and financial institutions in this period. In the second place, we want, using our financial restriction measures, to verify if the credit policies of the Banco Central do Brasil during the Covid-19 pandemic had any positive effect in mitigating credit restrictions of these firms. Our preliminary results show that our financial restriction measures explain well the capacity Brazilian private firms have to access credit for investment, as well as, indicate that investment is negatively related to financial restrictions in Brazil. Furthermore, our preliminary results also show that credit policies of Banco Central do Brasil had positive effect on working capital loans of firms but did not have any effect on investment in the Covid-19 pandemic period.

Keywords: financial restrictions measures, investment, private firms, Covid-19 pandemic, Banco Central do Brasil

JEL: G13, G32, G38

1. Introduction

Financial restrictions are a key and widespread concern for firms, thwarting their ability to carry out their optimal investment policies and growth trajectories. They are very important both in academia and for policy makers. In the case of the former, they are very relevant both in theoretical and empirical work related to Macroeconomics, Corporate Finance, Monetary Economics, Game Theory and Economics of Contracts. In the case of latter, they are relevant to measure the stance of the credit market in the economy.

Although the existing theoretical literature on the effect of financing constrains on firms' performance is very extensive, empirical contributions are rather scarce and more recent. In addition, despite its enormous importance, measuring financial restrictions is still subject to much discussion, because most empirical studies have not only to deal with a set of measurement and conceptual issues, but also to rely on tenuous relationships between firms and banks to identify the presence and severity of financial constraints.

The very definition of financial restrictions is not clear-cut. One can address several aspects of the relationship between firms and banks to extract measures of financial restrictions.[1] One common feature of all financial restriction measures, however, is the one that differentiates them from financial distress measures. A firm can be healthy and efficient in economic and financial terms, therefore not in distress, and still be credit restricted for some reasons.

In this paper, we will use a definition of financial restrictions related to the capacity a firm has to obtain credit with banks to implement positive present value investments or projects.[2] So, just to exemplify and make our definition more clear, let us suppose a certain firm has a positive present value investment and does not have all the monetary resources necessary to undertake this investment. The firm asks for loans in several banks for this purpose and all banks deny it. In accordance with our definition, this firm is financially constrained.

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[1] Kaplan and Zingales (1997) use a broader definition by stating that financial constraints are present whenever there is a wedge between the costs of obtaining internal and external funds. However, the problem with such definition is that it almost covers every firm.

[2] This definition is a very common one in the empirical literature that measures financial restrictions (see Fazari, Hubard and Petersen (1988) for a discussion).

Of course, an empirical researcher wanting to gauge if the firm is financially restricted or not would have difficulty to do so, looking only at the loan data of this firm. To have a better grasp of this, he should have to ask the firm if it has a positive present value investment that it wants to implement and needs credit from banks for this, and ask each bank that denied the credit for this purpose why it did so. This makes financial restrictions in empirical work non observable and hence very difficult to measure. No wonder, empirical researchers have been struggling for a long time and devoting a lot of hard work in trying to measure financial restrictions of firms in an appropriate manner.

Our main objective in this paper is to create financial restriction measures based on microdata related to bank loan contracts of Brazilian private firms. To understand how our measures of financial restrictions can contribute to the empirical literature, it is important to describe very briefly the actual state of the art of the empirical literature on this issue. As Silva and Carreira (2012) point out, there are three types of financial restriction measures: indirect measures, direct measures and indexes.

Indirect measures look at the sensitivity of investment in relation to cash-flow. The fundamental idea is that if sensitivity is high, then there is an indication that the firm may be financially restricted. To test for this possibility, firms are separated in two groups- more likely to be financially restricted and less likely to be financially restricted- based on ex-ante classification related to balance sheet characteristics of firms.

The seminal empirical paper of indirect measures is Fazari, Hubbard and Petersen (1998). The authors use firm´s dividend policy to classify them in financially restricted or not. Firms that pay more dividends would be less likely, while firms that pay fewer dividends would be more likely to be financially constrained. The intuition behind this classification is that firms that pay fewer dividends use more internal resources to invest, due to the fact that they have credit restrictions.[3]

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[3] Kaplan and Zingales (1997) question this classification and show that many firms in the sample they used in their sample paid very little dividend but had no indication of being financially constrained. The authors cite Hewlett-Packard as an example of a firm of this sort.

There are many other ex-ante classification possibilities of financial restrictions based on balance sheet information of firms. One that is widely used and has the advantage of being exogenous is size (see Oliveira (2019) for Brazil´s data and Campelo et al. (2013)).[4]

Instead of looking at investment cash-flow sensitivities, Almeida et al. (2014) look at the cash policy of firms and analyze the cash sensitivity to cash-flow. The main idea of Almeida et al. is that if a firm hoards cash than it is probably because it wants to have enough liquidity to undertake its investments without asking banks for credit.[5]

Indirect measures have some drawbacks. The main concern is that all of them are associated with average Q of Tobin. This firm multiple is used to identify investment opportunities. Average Q of Tobin is a proxy for marginal q of Tobin (1969), which the neoclassical theory of investment considers to be the correct measure to identify the set of investment opportunities. The problem is that average Q may be a bad proxy for marginal q, as Erickson and Whited (2000) show. It may also be the case, as Clearly et al. (2007) stress that cash flow may also contain information on investment opportunities, in particular when there is high uncertainty about firm´s investment projects.

As it is impossible to measure marginal q correctly, this makes tests of investment cash flow sensitivity based on indirect measures imprecise in statistical terms. Another problem with average Q of Tobin is the fact that it only exists for listed firms. However, listed firms are by definition the ones that would normally have more access to credit. In contrast to listed firms, private firms are the ones that should be more prone to depend on banks for investment.

Direct measures of financial restrictions, different from indirect measures, do not use average Q of Tobin. They are built on surveys and reports of firms. They are firm specific, time varying, and a researcher can use them as dependent or independent variable in their studies. For instance, in the case of reports, Kaplan and Zingales (1997) read them, searching for expressions that are symptomatic of the presence of financial constraints.

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[4] The most common way to measure size is by total assets, although some authors also use number of employees. The age of the firms is also exogenous and also used. In general, however, age and size are highly correlated.
[5] There are other balance sheets or financial characteristics used in the indirect measures, such as credit ratings, or capacity a firms has to give collaterals for loans, among others. See Silva and Carreira (2012) for more details

Another possibility to create direct measures of financial restrictions is through surveys.[6] In surveys, firms are asked whether they are financially restricted or not and this can be done by a single question or combination of different questions, related to their cost of external funds, credit denials, and availability of external funds. The main advantage of surveys is that firms are the best informed agents with respect with the quality of their projects. One should expect that investment opportunities are already taken into account in firm´s responses. It is also possible to measure financial restrictions for small and young firms that do not publish their balance sheets, which is not possible in the case of indirect measures. To complement survey information, one can also use quantitative information as well.

Like indirect measures, direct measures have also some downsides. The subjective nature of self-assessed variables means that potential biases resulting from management perceptions may exist. In addition, information is expensive to collect, somewhat scarce, with insufficient level of detail. It is also important to complement surveys with information coming from financial institutions, which is seldom available.

The third type of measure of financial restrictions is indexes. They are a combination of direct and indirect measures. Kaplan and Zingales (997) and Whited and Wu (2006) are some most important and cited indexes in the literature. They are built based on qualitative and quantitative information and share the advantages and disadvantages of direct and indirect measures.

We think that our paper contributes in an important way to the literature because our measures of financial restrictions are more accurate than the ones that exist in the literature so far. As far as we know, this is the first paper in the literature to construct measures of financial restrictions by analyzing information directly from loan contracts of firms with financial institutions. We use information of 1,316,455 loan contracts of 5,664 private firms that are registered at System of Credit Registry (hereafter SCR) of the Central Bank of Brazil written with banks each year from 2010 to 2020.

The SCR allow us to have a better comprehension of the capacity these firms have to access credit for investment. So for example, we know that the firm is in liquidation or in

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[6] See, for example, Campelo et al. (2010), Beck et al. (2008) and Eupean´s (ECB)´s Acess to Finance Survey.

bankruptcy in which case it will be very unlikely to obtain credit for investment. The SCR also informs the motive or type of the loan contract. There is information that the firm obtained credit for investment or for project financing in which case we also can deduce that the firm is not credit constrained for investment. There is also very detailed information on the maturity and interest rates of loans, the number of financial institutions with which a firm has a relationship, if the firm has any delinquency over 90 days among other very relevant credit information.

We classify a firm every year of our sample in five different categories depending on its likelihood to obtain credit for investment: very likely to be financially restricted (liquidation or restructuring), likely to be financially restricted, not capable of identifying, likely not to be financially restricted and very likely not to be financially restricted (in the case the firm obtained credit for investment or project financing). Our core measures of credit restriction classify firms in a certain year as likely to be financially restricted or not, depending on how average interest rate and average maturity of their contracts fit in the distributions of interest rates and maturities of all loan contracts of firms written in a certain year with financial institutions.

We build also other measures that complement our core measures with information related to: the number of financial institutions the firm writes contracts with; if the firm has loans in delinquency over 90 days; if the firm has a non performing portfolio of loans higher than 70% of its total portfolio; if the firm has outstanding foreign exchange derivatives contracts; and by looking at that some balance sheet characteristics such as coverage ratio, fixed assets and size (total assets).

We also think that we contribute to the literature because we study predominantly private firms, which is also not common in the literature. Most papers that measure financial restrictions look only at listed firms that should be much less likely to be credit constrained for investment.

Our financially restricted measures have most of the desired properties of such measures as Silva and Carreiro (2010) argument, such as being simple, objective, firm specific and time varying. In addition, given our financial restricted measures we may understand better investment cash flow sensitivity in Brazil.

Our preliminary results show that our financial restriction measures explain well the capacity Brazilian firms have to access credit for investment, as well as, indicate that investment is negatively related to financial restrictions in Brazil. Furthermore, our results also show that credit policies of Banco Central do Brasil (hereafter BCB) had positive effect on working capital loans but did not have any effect on investment of private firms in the Covid-19 pandemic period.

The remainder of the paper is the following. Section 2 describes very briefly the literature on financial restrictions measures. Section 3 describes the data. Section 4 presents our empirical identification strategy. Section 5 shows the results of the main empirical and robustness empirical analyses. Section 6 concludes.

2. Literature Review of Financial Constraints Measures

The theoretical literature on measures of the relation between financial constraints of firms and investment is based on the relaxation of the hypothesis of perfect markets of Modigliani-Miller (1958)´s theorem. Modigliani-Miller demonstrate that, in perfect capital markets, external finance is a perfect substitute for internal finance, thus financial structure of firms and financial policy is irrelevant for its investment decisions.

Stiglitz and Weiss (1981) and Myers and Majluf (1984) document well the consequences of capital market imperfections due to agency problems. The fundamental idea is based on the existence of moral hazard and adverse selection problems that either set the price of credit on above-optimal levels or rationalize (in some circumstances by complete) credit. This inefficiency sets a wedge between internal and external forms of firm´s financing. As a result, firm´s investment decisions will not be optimal and they will not be able to fulfill their growth and investment optimal targets.

The problems with asymmetric information in capital markets can be more severe for small and young firms. This will happen either because there is still not much information on these firms available to most potential lender. Potential lenders are not able to observe the quality of the risk or do not have control over the firm's investment. Under these conditions,

smaller and younger firms are expected to be more credit constrained, as shown by Petersen and Rajan (1994, 1995).

Empirical work related to the measurement of financial restrictions and its relation to investment can be decomposed in three distinct strands, as we explained in the Introduction: indirect measures, direct measures and indexes. Indirect measures are related to the study of the sensitivity of investment to cash-flow; direct measures are based on surveys and off-balance sheet reports of firms, while indexes are based on combination of direct and indirect approaches.

To measure the sensitivity of investment to cash-flow, indirect measures use regressions based of investment as a dependent variable and average Q of Tobin and cash-flow as explanatory variables, besides separating the sample of firms in credit constrained and non-constrained firms. The null hypotheses of these tests are that cash-flow sensitivity is going to be higher for constrained firms than for unconstrained firms.

To separate firms ex-ante in financially restricted or not, the literature uses several balance sheet or financial characteristics such as: assets, age, number of employees, credit ratings, number of bank relationship.[7]

Average Q of Tobin is a proxy for marginal q of Tobin(1969). Marginal q of Tobin measures the increase in the present value of a firm's profits resulting from a marginal increase in the firm's capital stock and is non-observable.[8] There are several ways to define average Q. One that is very common in the literature is the ratio between the market value of the firm and its cost of capital replacement. As this cost of capital replacement is not observable, total assets or fixed are often used as substitutes in the literature. A high level of Q thus indicates the presence of investment opportunities. It is argued that Q (or marginal q being more precise) summarizes all future information that is relevant for a firm when deciding to invest.

A relevant setback with average Q of Tobin is the fact that it only exists for listed firms that are naturally less credit constrained then private firms. An interesting alternative to

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[7] See Silva and Carreira (2010).

the estimation of Investment without Q of Tobin is developed in Gala and Gomes (2013). The authors estimate investment demand without information about market values and hence average Q of Tobin, but under general assumptions about technology and markets.

The seminal work on financial restrictions measured in indirect way is Fazari, Hubard and Petersen (1988). The authors investigate the impact of cash-flow sensitivities on investment by classifying firms according to their dividend policy. The reason for this classification rests on the argument that firms that pay low dividends, due to the fact that their needs for resources for investment exceed their internal cash flow and they are credit constrained. They show using a a sample consisting of 422 USA firms from 1970 to 1984 that the coefficient of cash-flow for the low-dividend group is higher and statistically different than the coefficient for the high-dividend group. This suggests that low-dividend firms invest more of their extra cash-flow than high-dividend firms.

On the other hand, Kaplan and Zingales (1997) argue that cash-flow is not a good measure of the existence of financing constraints and Fazzari, Hubbard and Petersen's (1998) a priori classification of firms is flawed. They instead classify firms according to information obtained from company annual reports and find evidence that constrained firms are the less sensitive to cash-flow. This argument is also supported by Kadapakkam et al. (1998) and Cleary (1999). Recently, Dasgupta and Sengupta (2007), for Japan, find that the response of investment to cash-flow shocks is non-monotonic, supporting Kaplan and Zingales (1997) and Cleary (1999).

Alternatively, analyzing firms' demand for cash, Almeida et al. (2004) claim that the level of financial constraints can be measured by the sensitivity of cash stock to cash flow. The rationale behind is that, while constrained firms need to save cash out of cash flows in order to take advantage of future investment opportunities, unconstrained firms do not, as they are able to resort to external finance. Meanwhile, firms that hold cash incur in opportunity costs associated with present investment opportunities. As a result, only constrained firms will need to optimize their cash stocks over time in order to maximize their profits and hedge

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[8] Hayashi(1981) demonstrates that in perfect capital markets average Q is equal to marginal q.

future socks by holding cash. Therefore, one can expect that estimates on the sensitivity of cash stocks to cash-flow.

Another facet of the literature points that cash-flows might contain information about firm's investment opportunities, meaning that Q should be corrected, as Alti(2003) and Bhagat et al. (2005) point out. Alti finds that even after Q correction, every firm in his sample shows sensitivity to cash-flow. In addition, Bhagat et al. find evidence that financially distressed firms exhibit positive investment-cash flow sensitivities if they operate at a profit, low sensitivity if operate at a loss.

Close bank relationships facilitate the contact between firms and banks, reducing the information asymmetries, which means lower financing constraints for firms (in particular if such relationships are stable). As Diamond (1991) argues, the risk associated with any particular loan is not neutral with respect to the duration of the relationship. As a result, one can expect differences in financial constraints between market-oriented economies (such as the USA and the UK) and bank-oriented ones (Germany for example.

An interesting empirical paper that studies firm´s bank relationships is Karainov et al. (2010). The authors examine whether financial constraints affect firms' investment decisions by comparing a group of unbanked firms to firms that rely on formal financing. Specifically, they combine data from the Spanish Mercantile Registry and the Bank of Spain Credit Registry (CIR) to classify firms according to their number of banking relations: one, several, or none. They show that financial constraints are negatively related to the number of bank relationships firms have.

In the case of direct measures, one can read the annual reports of firms (in the case only listed firms) and look for words or expressions of word that give some hint of financial difficulties a firm is facing such as Kaplan and Zingales (2007) did. Otherwise, one can prepare surveys for firms to answer one or more questions related to their cost of external funds, credit denials, and availability of external funds, as in Campello et al. (2010)., Beck et al. (2008), ECB´s survey on the access to finance of enterprises (SAFE) and Ferrando and Mulier (2013).

Campello et al. (2010) survey 1,050 chief financial officers (CFOs) in 39 countries in North America, Europe, and Asia in December 2008. They contrast the actions of firms that are financially constrained with those that are less constrained. They develop a survey-based measure of financial constraint and then study whether this constraint measure identifies meaningful cross-sectional variation in corporate behavior during the crisis.

Beck et al. (2008) examine whether financial development boosts the growth of small firms more than large firms and hence provides information on the mechanisms through which financial development fosters aggregate economic.

The ECB´s survey on the access to finance of enterprises (SAFE) provides information on the latest developments in the financial situation of enterprises, and documents trends in the need for and availability of external financing. The survey results are broken down by firm size, branch of economic activity, country, firm age, financial autonomy and ownership. The survey is conducted twice a year.

Ferrando and Mulier (2013) draw on SAFE survey of 11,886 firms in the euro area to investigate the role of firm characteristics with respect to the experience of facing financial restrictions from 2009 to 2011. Their methodology is based on nearest neighbor matching of the firms in their sample with balance sheet information of 2.3 million firms in euro area. They are capable of distinguishing perceived from actual financial obstacles and they show that more profitable firms are less likely to face actual financing constraints.

The third strand of the literature is indexes. They combine indirect and direct measures and thus have the advantages and disadvantages of them. They have quantitative as well as qualitative information. Some of most important indexes in the literature are Kaplan and Zingales (1997) and White and Wu(2006).The Kaplan-Zingales index is a relative measurement of reliance on external financing. Companies with a higher KZ-Index scores are more likely to experience difficulties when financial conditions tighten since they may have difficulty financing their ongoing operations. The index is based on a five-factor model of the following variables: cash-flow, Q of Tobin, Total Debt, dividends and Cash.

Whited and Wu's (2006) index is derived from a generalized method of moments estimation of an investment Euler equation. The lagrange multiplier on the external financing constraint is the shadow cost of external financing. It is a function of five factors: ratio of total debt to total assets, indicator if the firm pays or not dividends, the growth of firm´s sales, the growth of the firm´s sector and cash divided by total assets.

The existence of financing constraints appears to be particularly severe for firms that decide to invest in R&D because of the risks associated with the investment. As argued before, credit markets will no longer be efficient, generating a wedge between internal and external financing faced by firms as well as a financing hierarchy. For example, Hall (1992), and Himmelberg and Petersen (1994), find support for the hypothesis that R&D investment is financially constrained in particular for small firms. Hall et al. (1999) in a comparative study of French, Japanese and the USA firms also sustain these findings.

The financial constraints faced by firms can obviously have important effects on the firm's ability to stay in the market. For example, Musso and Schiavo (2008) find that, for French manufacturing firms over the period 1996-2004, the greater the financial constraints firms face, the higher the probability that they do not survive and then exit the market.

3. Data

We have two sources of data. The balance sheet and financial information of firms comes from Valorpro. [9] Valorpro has the advantage of having information mostly on medium to small size private firms (hereafter firms), which are our main interest in this paper. The information of firm´s loan contracts come from SCR.

Our database of firms has unbalanced balance sheet and financial information of 5,664 firms from 2010 to 2020. We classify these firms in 5 sectors, following the classification sheme of Valorpro: Agriculture, Commerce, Energy, Industry and Services. As Table 1 once again shows the majority of private firms in our database come from the services sector.

[Insert Table 1]

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[9] Valorpro is a database of balance sheet and financial information of firms. It is a proprietary database od the Brazilian economic journal *Valor Econômico.*

Table 2 Panel A displays the descriptive statistics (mean and standard deviation) of balance sheet and financial of private firms that we employ in our empirical analyses. The largest ones (measured by the natural logarithm of total assets) come from the energy sector followed by the industry sector. With the exception of the agriculture sector, average investment of private firms in relation to total assets is negative, which indicates that private firms from these sectors are not investing enough to compensate for depreciation of capital stock. The most profitable sector, measured by the quotient between Ebitda and total assets, is the services sector, and the one with the highest leverage is the energy sector. In terms of operational revenues, on average, the commerce sector has the highest in relation to total assets. As Table 2 shows our database of firms is mostly comprised of small to medium size firms.

Table 3 Panel C shows the number of foreign exchange derivatives contracts of our database firms classified by type of derivative and long or short positions. Future contracts are predominant, followed by forward contracts. Most firms are long in the foreign exchange rate.

[Insert Table 3]

In the case of loan contracts, we use the information of SCR. The SCR is an outstanding database of loan contracts written between individuals, firms and financial institutions. Our interest in this paper is loans of firms.

The SCR has flow, stock and cadastral information of these loan contracts. In the case of cadastral information, SCR informs if the firm is in liquidation or in a restructuring process due to a bankruptcy process. In the case of flow information, one is able to observe, among other features of the loan contracts, the date the contract was written, interest rate charged, maturity and motive or type the loan contract, and the credit risk of the loan. Stock information, for example, relates to if it has more than 90 days delinquency in some loan, the relative importance of bad loan in relation to the total portfolio of loans, the number of bank relationship the firms has, among others.

In our empirical identification strategy, as we will make clear in next section, we will use all the information of loan contracts mentioned above. In case of flow information, we are interested in contracts written between firms and financial institution from 2010 to 2020.

Figure 1 shows the total number of loan contracts written every year from 2010 to 2020 by firms in our sample registered at SCR. It is interesting to observe that there is a sharp decline on the number of contracts between 2014 and 2016. We conjecture that this may have happen because of a decrease in GDP growth, which had to do with bad fiscal situation observed in Brazil during these years.

[Insert Figure 1]

The information contained of loan contracts in SCR allows us to distinguish firms that are in liquidation or restructuring due to a bankruptcy process. Figure 2 shows the number of firms in such situations changed little in the period. The number of firms in these situations is relatively stable until 2016 when it grows very fast, with the highest number being 192 in 2020.

[Insert Figure 2]

We classify the type or motive of the loan contract in three categories: working capital, financing and investment or project finance. Working capitals are all sorts of loans that are not for financing or investment reasons. Examples of these kinds of loans are bank discount of credit instrument, secure overdraft facilities, long-term working capital, short-term working capital, credit card receivable financing, among many others.

Financing loans, on the other hand, exist for the purchase of goods, whether mobile or immovable. Normally, and as a rule, interest rates are lower and maturities are higher for financing loans than for those working capital loans, since the financed asset is, normally, given as collateral until the debt is paid off. It is not clear, however, that, in the case firms are acquiring financing loans that they are investing, that is, increasing their capital stock.

In addition, we have information about loans for project financing or investment, which is crucial for our empirical identification strategy because it indicates firms that are acquiring these loans to increase their capital stock.

Figure 3 presents the percentage of types of loans contracts of the firms in our database from 2010 to 2016. Figure 3 shows that working capital loans exceed by far loans for financing and investment or project financing in all years. It is important to note that almost all loans in 2020, in which occurred the Covid-19 pandemic (hereafter pandemic), were working capital loans. We think that this has to do, as we will mention later on in the text, with the credit policies of Banco Central do Brasil implemented during the pandemic so as to mitigate its effects on financial restrictions of firms.

[Insert Figure 3]

4. Empirical Identification Strategy

4.1 Identification of Financial Restriction Measures

Our empirical identification strategy of financial restrictions measures is the following. We start by defining five categories of firm´s relative access to credit for investment. The categories are the following: very likely non-financially restricted, likely to be financially restricted, not enough information to classify, likely to be non-financially restricted and very likely to be non-financially restricted.

Table 4 presents our financially restricted measures based on the categories above. All our measures are calculated every year, so they can change in our sample period. Our core measures presented in Table 4 Panel A are FR1_Contracts, FR2_Contracts, FR3_Contracts.[10] FR1_Contracts, FR2_Contracts and FR3_Contracts are equal to 1 for a certain firm in a certain year if the firm is in restructuring or liquidation in that year; they are equal to 5 in a certain year if the firm obtained loans for investment or project financing; they are equal to 3 if we do not have enough information to measure they financing restrictions.

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FR1_Contracts, FR2_Contracts and FR3_Contracts differ in the way they fall in the categories 2 or 4. For a certain firm in a certain year, FR1_Contracts is equal to 4 if the firm acquired financing loans in that year or acquired only working capital loans and the average interest rate of these working capital loans was lower than the 30% percentile of the cross section distribution of interest rates in that year and average maturity of these working capital loans was higher than the 70% percentile of the cross section distribution of maturities of all working capital loans in that year. FR1_Contracts is equal to 2 if the firm acquired obtained only working capital loans and the average interest rate of these working capital loans was higher than the 70% percentile of the cross section distribution of interest rates in that year and average maturity of these working capital loans was lower than the 30% percentile of the cross section distribution of maturities of all working capital loans in that year.[11]

FR2_Contracts and FR3_contracts differ from FR1_Contracts, because they consider the 80% and 90% percentile respectively of the distribution of cross section maturities instead of the 70% percentile, and because they use the 20% and 10% percentile of the cross section distribution of interest rates respectively instead of the 30% percentile.

We build other financial restriction measures that complement our measures above using information of firms related to the number of delinquency days of their of loans, from their demand of foreign exchange derivatives, from their bank relationships, from information of their portfolio of non-performing loans (bad loans) and from some balance sheet information. These information are relevant because they can change the classification of our core measures in category 3 (unable to classify) into categories 2 (likely to be restricted) or 4(likely to be non-restricted).

Therefore, as Table 4 Panel B shows FR1 (2,3)_Contracts_Delinquency change the correspondent classification of 3 to 2 in a certain year, if we observe that the firm had loans in delinquency over 90 days in that year.   Table 3 Panel B also displays that FR1(2,3)_Contracts_Bad_Portfolio change the correspondent classification of 3 to 2 of core measures in a certain year, if more than 70% of the loan portfolio of the firm in that year is considered to be non-performing.

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[10] FR is an acronyms for financial restrictions.

We also extend our core measures by looking at some balance characteristic of the firm. Table 3 Panel C shows that FR1(2,3)_Contracts_Balance_Sheet modify the classification from 3 to 2 when total assets, fixed assets and coverage ratio is less than the 30% percentile of their respective distribution in the year, while FR1(2,3) Contracts_Balance_Sheet modify the classification from 3 to 4 when total assets, fixed assets and coverage ratio is higher than the 70% percentile of their respective distribution in the year.

Finally, Table 3 Panel D presents a financial restriction measure based on firm´s bank relationships, FR_QFIs, following Karainov et al. (2010). If the firm in a certain year has no bank relationship, this measure is equal to 1; if the firm has one bank relationship this measure is equal to 2 and if the firm has more than one bank with which it transacts then this measure is equal 3. The idea is that if the firm has no bank relationship in a certain year then it is an indication of the firm being more likely to be credit restricted, while more than one bank relationship is an indication of the firm being less likely to be financially restricted.

[Insert Table 4]

Therefore, we have a total of 13 different measures of credit restriction of firms in our sample. To select only one that we think more appropriate for firms, we do the following. We estimate ordered probit panels, where the dependent variables are our measures of financial restrictions explained above and our explanatory variables are the one used in the Whited and Wu index (2006), that is: ratio of total debt to total assets, growth of firm´s sales, growth of the firm´s sector and cash divided by total assets.[12]

We then select the best a-prior classification of finance restriction as the one in which the average observed probabilities of forecasting all categories of financial restriction above, with the exception of category 3, in our ordered panel probit estimations is the highest.

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[11] The 0.7 and 0.3 thresholds are adopted as a simple back-of-the-envelope rule, commonly used in many empirical works, see Moore et al. (2013).

After selecting the best a-prior classification for each group, private and all firms, we define a firm as financially restricted in a certain year if its classification in that year is very likely (1) or likely (2) to be financially restricted. Otherwise, we consider a firm to be non-financially restricted if its classification falls in categories likely (4) or very likely (5) to be financially non-restricted.

4.2 Investment Demand

We use our selected financially restricted measures to estimate investment demand regressions of our unbalanced panel of firms from 2010 to 2020. We have different estimations depending if the group is made of financially restricted or non-restricted firms.

In our main empirical analyses, we estimate Equation (1) and Equation (2) below, using an unbalanced panel. Equation (1) adapts Fazari et al. (1988), substituting Q of Tobin for the lead of the variation of operational revenue (var_rev_oper). Equation (2) is a vector error correction model of investment (see Bond et al. (2003)), where there is an error correction vector of sales and fixed assets lagged two periods in addition to a regressor of sales growth. We estimate both equations with random effects, controlling for heterocedasticity with sectors as clusters. [13]

In all estimations, we include a regressor that is an interaction between ebitda_assets (a measure of cash flow) and pandemic, which is equal to one in 2020 and zero otherwise. During 2020, BCB implemented several credit policies to decrease the effect of the pandemic on credit restriction of firms. With this regressor we want to verify if these credit policies where effective in particular for firms that we classify as financially restricted. Table 5 presents a list of some of credit policies of BCB.

The null hypotheses that we want to test are, that for the group of financially restricted firms, the estimated parameter β_2 is positive and statistically significant, while for the group of non-financially restricted firms either β_2 is non-significant statistically or negative and

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[12] We do not have information on dividends, so that is why we do not list it. We prefer Whited and Wu (2006) index from Kaplan and Zingales (1997) index because the former does not use Q of Tobin, which is important in our empirical analyses, because the great majority of firms in our database are private ones.
[13] See Oliveira(2019) for a discussion on investment demand specifications for Brazil.

statistically significant. Furthermore, we want to verify if the credit policies of BCB during the pandemic have any positive effect on investment of financially restricted firms, that is we want to test if β_3 is negative and statistically significant for these firms.

$$\frac{capex_{it}}{Assets_{it-1}} = \beta_0 + \beta_1 \, var\_rev\_oper_{t+1} + \beta_2 \frac{Ebitda_{it}}{Assets_{it-1}} + \beta_3 \frac{Ebitda_{it}}{Assets_{it-1}} \, pandemic_t$$
$$+ \gamma Sectors_i + a_i + u_{it}$$
$$(1)$$

$$\frac{capex_{it}}{Assets_{it-1}} = \beta_0 + \beta_1 \frac{capex_{it-1}}{Assets_{it-2}} + \beta_2 \frac{Ebitda_{it}}{Assets_{it-1}} + \beta_3 \frac{Ebitda_{it}}{Assets_{it-1}} \, pandemic$$
$$+ \beta_3 \Delta \log(sales)_{it} + \beta_4 \left(sales_{it-2} - Fixed\_assets_{it-2}\right) \frac{capex_{it-1}}{Assets_{it-2}} + \gamma Sectors_i + a_i + u_{it}$$
$$(2)$$

In the next section, we will present the results of our main empirical analyses and robust exercises.

5. Results

5.1 Financial Restrictions Measures

Table 5 Panel A shows the average correlation between all our measures of financial restrictions. As one can see, all measures are highly correlated to each other, which implies that incorporating information of delinquency, non-performing portfolio of loans, foreign exchange derivatives contracts, balance sheet and bank relationship to our flow financial restriction measures (core measures) does not increase in a substantial way our understanding of financial restrictions of the firms in our sample.

Table 5 Panel B shows the average probabilities of the best model´s forecasts of the categories of our ordered dependent variables. The FR1_contracts is the one with the highest probability of fitting (0.61), followed by FR1_balance sheet (0.52).

[Insert Table 5]

Figure 4 displays the evolution in our sample period of the number of private firms in each category of financial restriction measures based on FR1_contracts.[14] One can see that categories very likely to be restricted and likely to be restricted, FR1 and FR2 respectively, are relatively stable in our sample period, similar to what happens to number of firms in the category very unlikely to be financially restricted, FR5. On the other hand, the number of firms in category likely not to be credit constrained, FR4, increases through time, at the same time the category 3, FR3, which is the one in which there is not sufficient information to determine if a firms is restricted or not has a negative trend. This indicates that, as time goes by, in one hand, firms are becoming less credit constrained and, on the other hand, there is more information in our database to make it possible to us to verify the likelihood of credit status of private firms.

[Insert Figure 4]

We define a firm as financially constrained (FR equal to 1) firm if it belongs to FR1_contracts categories of very likely (1) or likely (2) to be credit constrained. We define a non-financially constrained firm (FR equal to 0) if it belongs to category likely (4) or very likely (5) to be non-financially constrained. Figure 5 shows the year average classification of financially constrained and non-financially firms in our sample period. Both series look very stable throughout the years. Figure 6 shows the number of financially constrained firms classified by sectors. It is clear from Figure 6, that firms of the services sector, as one would expect, are the one with more firms with financial restrictions.

[Insert Figure 5]

[Insert Figure 6]

We perform mean tests of some characteristics of the group of private and all firms that are financially restricted or not. Table 6 shows that for the group of firms, firms that are non-financially restricted are larger and invest more than firms that are financially restricted. However, we do not see any statistical significant difference between the groups of financially restricted or not as far as profitability (Ebita/Assets) and growth of operational reserves are concerned (Var_Oper_Rev).

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[14] FR(1 to 5) means that FR1_Contracts_Derivatives is equal to 1 to 5 respectively.

[Insert Table 6]

5.2 Results of Estimations of Investment Functions

Table 7 Panel A and B present the results of our main estimations of investment demand for financially restricted and non-financially restricted firms, respectively.

The results in Table 7 Panel A and B show that the sensitivity of investment in relation to cash-flow (measured by the ratio of ebitda to assets) for financially restricted firms is positive and statistically significant, while the coefficient of the same regressor for the case non-financially restricted firms is negative and statistically significant. Both panels also show that in the pandemic period, the coefficient of the cash flow measure is not statistically significant, which may indicate, albeit in an imprecise manner, that credit policies of BCB Brasil during the pandemic did not mitigate the effects of credit restrictions on investment.

In the next section, we will present results of some robustness exercises to verify if the results of our main empirical analyses continue to occur.

[Insert Table 7]

5.3 Robustness Exercises of the Estimation of Investment

In a first attempt the robustness of our previous results, we estimate the same specifications presented in Table 7 only for the years 2019 and 2020. So by restricting only for these two years, we are doing difference-in-difference estimations, considering the pandemic as a natural shock. Table 8 Panels A and B displays the results and show that the sensitivity of investment to cash-flow continues to be positive and statistically significant for financially restricted firms, while non-significant or when significant negative for non-financially restricted firms and that these relations did not change in the pandemic period.

[Insert Table 8]

21

In a second robustness exercise, we cope with possible endogeneity of the regressors of equations (1) and (2) above, by estimating an average treatment effects models (ATE) . We use neighboring matching and propensity matching score, with financial restriction measures as the treatment variable, capex divided by assets in the previous year as the outcome variables and the same control variables we used in equation (1). We use two different groups of firms. One group, column (1) is made of firms thay may have zero capex, while the other group is made of firms that have only positive capex. Table 9 shows that previous results related to the sensitivity of investment to cash-flow do not change even during the pandemic period, .

[Insert Table 9]

In a third attempt to test the robustness of our results, we consider as financially restricted those firms with no bank relationship and financially non-restricted those firms with more than one bank relationship. We repeat the estimations of Table 6 Panel A and as one can see in Table 10 the sensitivity of investment to cash flow continues to be positive and statistically significant and that the pandemic period did not change this result.

[Insert Table 10]

We do other robustness tests, whose results, due to space restrictions, we do not report.[15] Just to mention some, we estimate specifications of Equations (1) and (2) classifying restricted firms only when all our financial restrictions measures are less or equal to 2 and all are non-financially restricted measures all our measures are greater or equal to 4. We consider financially restricted only those firms that are in category 1, liquidation or restructuring and non-finacially restricted those firms thar are only in category 5, project financing and investment. We include a level dummy equal to one from 2014 to 2016 and zero otherwise to control for deterioration of economic conditions in Brazil. In general, our previous results related to the sensitivity of investment to cash-flow do not change.

6. Conclusion

In this paper, we build financial restriction measures of 5,664 private firms in Brazil from 2010 to 2020. To build these financial restriction measures, we use microdata of 1,316,455 loan contracts written between these firms and financial institutions in this period.

Our financial restrictions measures do a good job in explaining the credit market of some small to medium size firms in Brazil that make up the bulk of our sample, and show that their investment is negatively related to the degree of their financial restrictions. Moreover, our results show that this did not change during the pandemic, despite efforts of BCB to relax credit restrictions of firms in this period.

We ponder that our paper not only contributes in relevant ways to the empirical literature but also in terms of policy. Considering the empirical literature, our paper creates measures of financial restrictions that, we think, are more accurate than the ones that exist in the literature so far. As far as we known, our paper is the first one in the literature to construct these measures by analyzing information directly from loan contracts of firms with financial institutions. In terms of policy, we think that our financial restriction measures can be used by policy makers to have a better understanding of the stance of the credit market for firms - especially private ones- in Brazil.

Future research could expand the number of firms to be studied, which depends, of course, on the availability of detailed balance sheet and financial information of private firms and in, in particular, of limited liabilities ones. Future research could also use firm´s loans contract in SCR to try to quantity agency costs, due to information asymmetries and moral hazards that could very well explain and even improve the financial restriction measures that we construct in this paper.

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[15] The results are available upon request by the reader.

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Table 1. Firms and Sectors

Our database of firms has unbalanced balance sheet and financial information of 3,577 private firms and 91 listed firms from 2010 to 2016. As Table 1 shows, there are 3,311 joint stock private firms and 266 limited liability firms. We classify these firms in 4 sectors, following the classification of Valorpro: Agriculture, Energy, Industry and Services.

	Number of Firms
Agriculture	121
Commerce	500
Energy	851
Industry	1,084
Services	3,108
Total	5,664

Table 2 Descriptive Statistics

Our database of firms has unbalanced balance sheet and financial information of 3,577 private firms and 91 listed firms from 2010 to 2016. Panel A shows mean and standard deviation (second number below) of balance sheet characteristics of private firms, while Panel B shows mean and standar deviation of listed firms. Panel C shows the number and type of foreign exchange derivatives contracts.

Panel A Mean and Standard Deviation Private Firms

	Agriculture	Commerce	Energy	Industry	Services
Logassets	11.8500	12.4700	13.4500	12.6100	12.2300
	1.6124	1.6862	1.5445	1.5980	1.8641
Capext/Assetst-1	0.2395	-0.2500	-0.2942	-0.2433	-0.2001
	-6.0445	2.4727	3.2027	0.5896	2.2734
Ebitdat/Assetst-1	0.0940	0.4800	0.1636	0.1104	0.4587
	0.2157	7.6754	1.4188	0.6969	8.6754
Revoper/Assets	0.0190	0.0688	0.0437	0.0180	0.0880
	0.1039	5.6783	0.6646	0.4393	3.2225
Debt/Assets	0.1463	0.1800	0.2483	0.1257	0.1305
	0.1600	0.3164	0.3588	0.1567	0.1629

Table 3 Number of Derivatives Contracts

Future		Options		Swap		Forward	
Long	Short	Long	Short	Long	Short	Long	Short
64,820	76,386	5,043	4,745	4,402	1,329	14,627	39,782

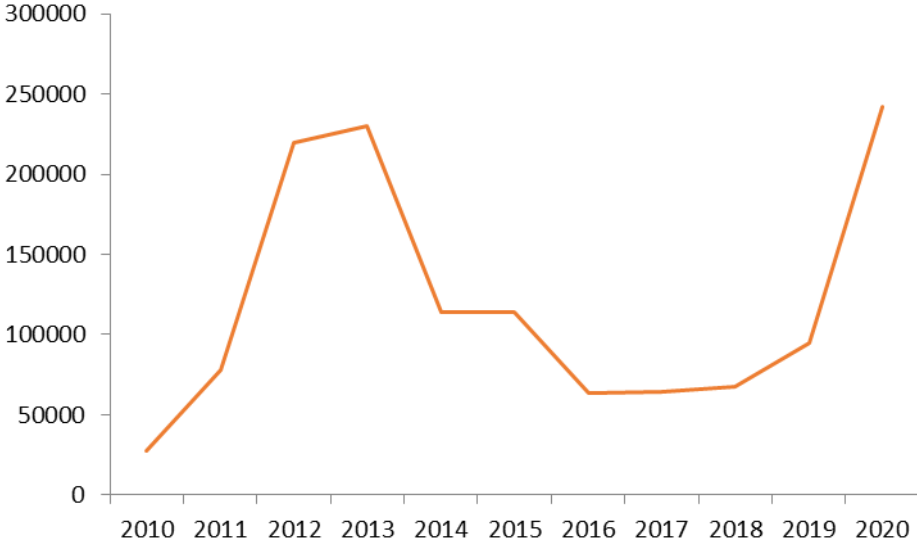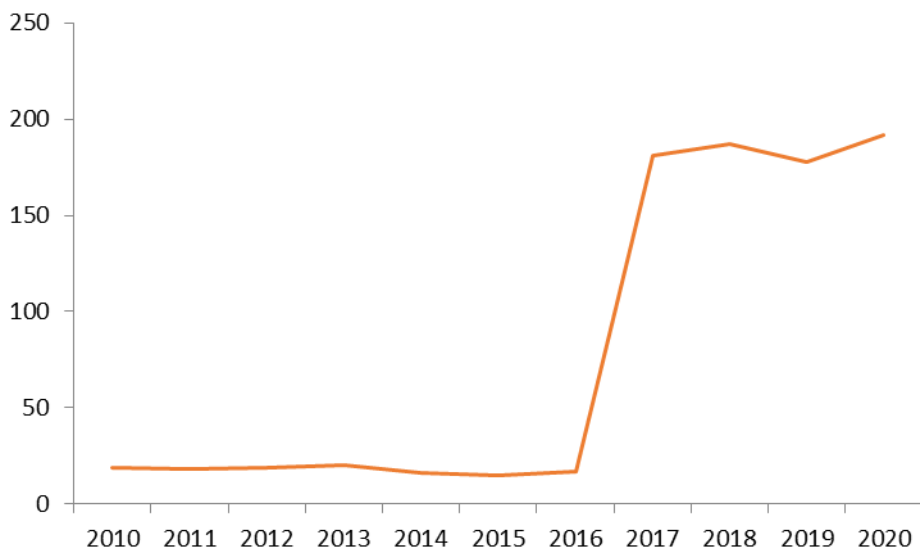**Figure 1 Number of Loan Contracts of Firms**

Figure 2 Number of Firms in Liquidation or Restructuring

Souce SCR of Central Bank of Brazil

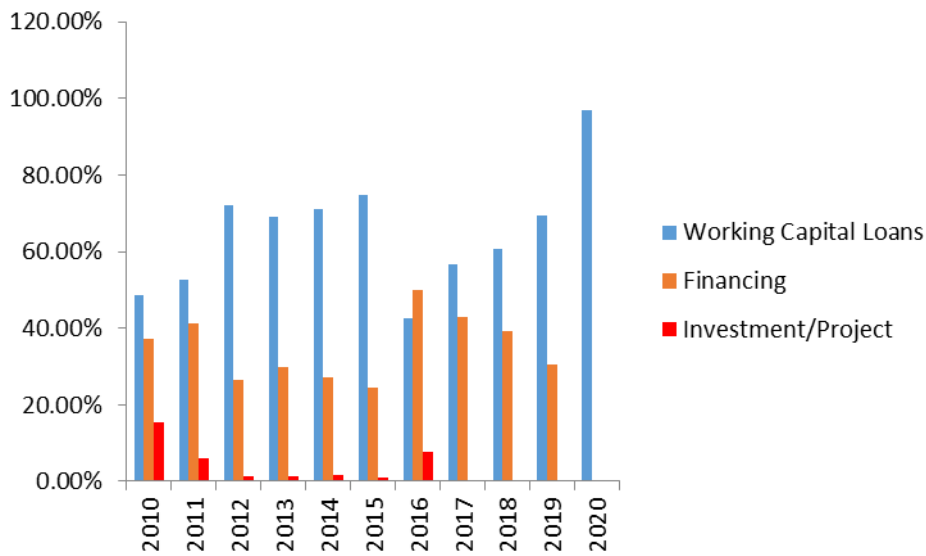**Figure 3 Percentages of Types of Loans Contracts of Firms**

Table 4 Financial Restriction Measures and Categories of Financial Restrictions

Panel A Core Financial Restriction Measures

FR1(2)[3]_	Categories	Contracts
1	Very Likely Financial Restricted	Information on Reestructuring or Liquidation
5	Very Unlikely to be Financially Restricted	Investment or Project Financing
2	Likely to be Financially Restricted	Only "Working Capital" and Average Interest Rate>70%(80%)[90%] percentil and average maturity lower than 30%(20%)[10%] percentil
4	Unlikely to be Financially Restricted	Financing and Average Interest Rate<30%(20%)[10%] percentil and average maturity higher than 70%(80%)[90%] percentil
3	Not Clear	No sufficient information to classify

Panel B Extensions of Core Financial Restriction Measures: Delinquency and Derivatives Contracts

FR1(2)[3]_	Categories	Contracts_Delinquency	Contracts_Derivative
1	Very Likely Financial Restricted	Contracts	Contracts
5	Very Unlikely to be Financially Restricted	Contracts	Contracts
2	Likely to be Financially Restricted	Loans >90 days delinquency	Contracts
4	Unlikely to be Financially Restricted	Contracts	Firms with outstanding derivative contracts
3	Not Clear	Contracts	Contracts

Panel C Extensions of Core Financial Restriction Measures: Bad or Non-Performing Portfolio of Loans and Balance Sheet Information

FR1(2)[3]_	Categories	Contracts_Bad_Portfolio	Contracts_Balance_Sheet
1	Very Likely Financial Restricted	Contracts	Contracts
5	Very Unlikely to be Financially Restricted	Contracts	Contracts
2	Likely to be Financially Restricted	>70% of total classified as bad loans	assets<30% percentil distribution and interest coverage<30% percentile and fixed assets/Assets<30% percentile
4	Unlikely to be Financially Restricted	Contracts	assets>70% percentil distribution and interest coverage>30% percentile and fixed assets/Assets>30% percentile
3	Not Clear	Contracts	Contracts

Panel D Financial Restriction Measures and Bank Relationships

QFIs	Categories	Definition
1	Likely Financial Restricted	No Bank Relationship
2	Not Clear	One Bank Relationship
3	Likely to be Non-Financially Restricted	More than One Bank Relationship

Table 5 Average Correlation and Selection of Financial Restriction Measures

Panel A Average Correlation of Financial Restriction Measures

	FR1s	FR2s	FR3s
FR1s	0.92		
FR2s	0.87	0.91	
FR3s	0.81	0.85	0.91
FR_QIFs	0.82	0.86	0.88

Panel B Selection of Financial Restriction Measures

FR	Average Prob (FR=1 or 2 or 4 or 5)
Fr1_contracts	0.61
Fr1_contracts_balance	0.52
Fr1_contracts_derivatives	0.53

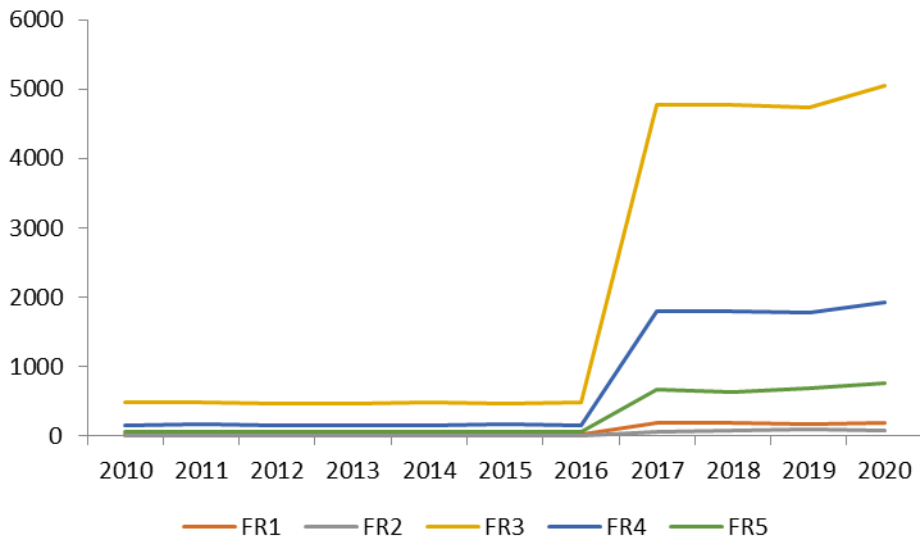**Figure 4 Financial Restriction Categories**
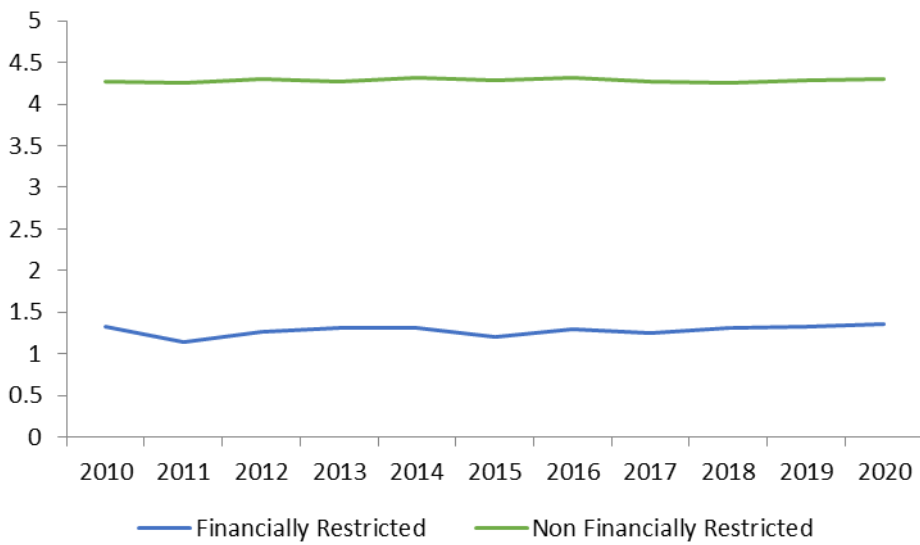

Figure 5 Average FR and NFR

Figure 6 Financial Restrictions and Sectors of the Economy
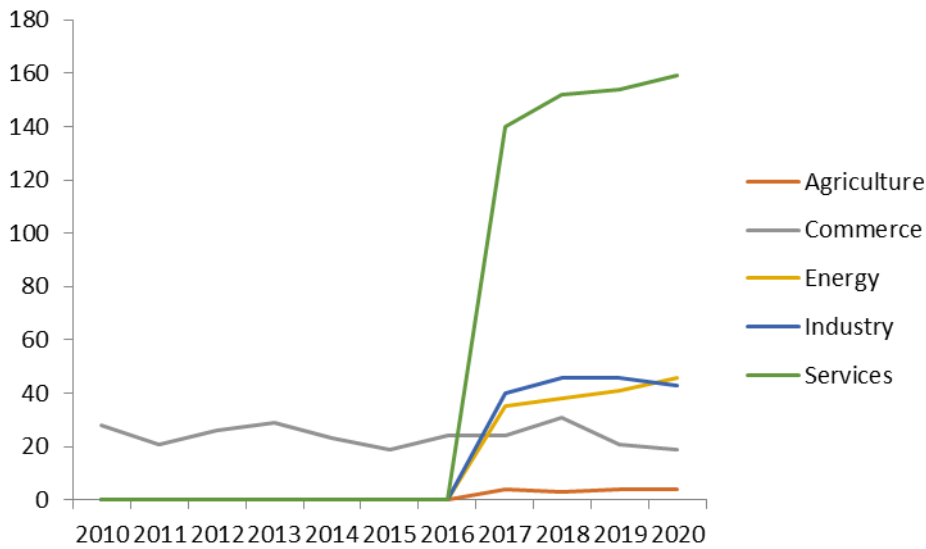
Table 5 Credit Policies of Banco Central do Brasil during Covid-19 Pandemic (2020)

Working Capital Program to preserve business continuity (CGPE)

Purchase of private securities by BCB in the secondary market

Deduction on reserve requirement on savings deposits conditional on credit provision to micro and small compa

Real estate may be used as collateral in more than one credit operation

Emergency program provides payroll financing to SME in order to preserve employment in the segment

Fostering credit for small and medium-sized enterprises

Relaxed provisioning rules for refinancing loans of SME for six months

Table 6 Mean Tests of Difference in Characteristics of Financially Restricted and non-Financially Restricted

	Private (FR=0-FR=1)	All (FR=0-FR=1)
Logassets	0.12***	0.55***
Capex$_t$/Assets$_{t-1}$	0.06*	0.05**
Ebitda$_t$/Assets$_{t-1}$	0.02	0.15
Var_Rec_Oper	-0.61	-0.68

Table 7 Investment Demand Estimations (Sample Period:2010-2020)

Panel A Adapting Fazari et al. (1988)
p-value under parenthesis. *p<0.10 ** p<0.05 ***p<0.01

	capex_assets	
	FR	NFR
var_rec_oper	0.075***	2.52***
	(0.00)	(0.00)
Ebitdat/Assets	26.08	11.02
	(0.41)	(0.58)
(Ebitdat/Assets)*pandemic	1.41E-9	-5.17E-8***
	(0.13)	(0.00)
Robust Covariance (cluster sectors)	yes	yes
Sectors	yes	yes
Random Effects	yes	yes
Obs	1650	5021

Panel B Vector Error Correction Model of Investment
p-value under parenthesis. *p<0.10 ** p<0.05 ***p<0.01

	capex_assets	
	FR	NFR
var_sales	42.08***	46.91***
	(0.00)	(0.00)
Ebitdat/Assetst-1	3019.1	-3623.15
	(0.21)	(0.89)
(Ebitdat/Assetst-1)*Pandemic	$1.44*10^{-7}$	$2.31*10^{-10}$
	(0.97)	(0.89)
Robust Covariance (cluster sectors)	yes	yes
Sectors	yes	yes
Random Effects	yes	yes
Obs	1421	3297

Table 8 Investment Demand Estimations: Difference-in-Difference Estimations (Sample Period: 2019-2020)

Panel A Adapting Fazari et al. (1988)
p-value under parenthesis. *p<0.10 ** p<0.05 ***p<0.01

	capex_assets	
	FR	NFR
var_rec_oper	0.031***	1.32***
	(0.00)	(0.01)
Ebitdat/Assets	14.02**	10.91
	(0.04)	(0.58)
(Ebitdat/Assets)*pandemic	1.21E-9	-5.17E-8
	(0.11)	(0.32)
Robust Covariance (cluster sectors)	yes	yes
Sectors	yes	yes
Random Effects	yes	yes
Obs	346	1341

Panel B Vector Error Correction Model of Investment

p-value under parenthesis. *p<0.10 ** p<0.05 ***p<0.01

	capex_assets	
	FR	NFR
var_sales	40.005***	41.82***
	(0.00)	(0.00)
Ebitdat/Assetst-1	30.23**	-30.16
	(0.021)	(0.89)
(Ebitdat/Assetst-1)*Pandemic	$1.44*10-7$	$1.21*10-10$
	(0.97)	(0.89)
Robust Covariance (cluster sectors)	yes	yes
Sectors	yes	yes
Random Effects	yes	yes
Obs	346	1341

Table 9 Average Treatment Effects Estimation

	ATE Capex/Assets	
	FR=1	FR=1 and capex>0
Nearest Neighbour Matching	-0.27***	-0.026***
	(0.01)	(0.02)
Propensity Matching Score	-0.026***	-0.35*
	(0.024)	(0.09)

*p<0.10 **p<0.05 ***p<0.01

Table 10 Investment Demand Estimations using Bank Relationships as Financial Restriction Measure

Panel A Adapting Fazari et al. (1988)
*p<0.10 ** p<0.05 ***p<0.01

	capex_assets	
	FR	NFR
var_rec_oper	0.015***	0.22***
	(0.00)	(0.00)
Ebitdat/Assets	12.13	10.21
	(0.41)	(0.24)
(Ebitdat/Assets)*pandemic	1.23*E-9**	-1.14E-7***
	(0.33)	(0.00)
Robust Covariance (cluster sectors)	yes	yes
Sectors	yes	yes
Random Effects	yes	yes
Obs	1650	5063

Panel B Vector Error Correction Model of Investment

*p<0.10 ** p<0.05 ***p<0.01

	capex_assets	
	FR	NFR
var_sales	42.08***	46.91***
	(0.00)	(0.00)
Ebitdat/Assetst-1	3019.1	-3623.15
	(0.21)	(0.89)
(Ebitdat/Assetst-1)*Pandemic	$1.24*10-7$	$2.31*10-10$
	(0.97)	(0.89)
Robust Covariance (cluster sectors)	yes	yes
Sectors	yes	yes
Random Effects	yes	yes
Obs	1320	4273