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Keywords: credit constraints, international trade collapse, investment decisions

JEL Codes: G32, E22, E51

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1 Introduction

In September 2008, the Lehman Brothers bankruptcy filling burst the United States (U.S.) subprime mortgage crisis. What was initially a financial crisis in developed economies soon spread worldwide via two main channels: a credit crunch, as banks sought more liquid assets and reduced lending, and an unprecedented reduction in demand for exports, known as the "Global Trade Collapse". These two channels are understood to be strongly correlated, considering that, when world trade fell 17% between the final quarter of 2008 and the first quarter of 2009, banks were not able to meet customer demand to finance international trade operations, creating an estimated US$25 billion deficit in the supply of trade finance (LAWRENCE; HANOUZ; MOAVENZADEH, 2009).

As Ahn, Amiti and Weinstein (2011) describes, ever since this episode, the major challenge in the macroeconomic literature has been to determine how standard econometric models could incorporate finance-based explanations of this negative scenario in the exporting sector in 2009. This article thus provides some evidence of the impact of funding shortage on Brazilian exporters' investments.

In Brazil, the macro backdrop during that period was less staggering compared to that in developed economies. Given the soundness of the local financial system and its low exposure to the mortgage-backed securities that triggered the financial crisis, local credit markets were not immediately harmed. Consequently, the slowdown in the economic activity of Brazil's major trading partners was pegged as the main culprit contributing to the downfall in exporting firms' investments (CHEUNG; GUICHARD, 2009).

However, mounting evidence suggests that credit tightening may have been an issue in the Brazilian exporting sector as well. Unlike other credit lines, those designated for exporters rely on the availability of external financing in foreign currency, which, in turn, depends on the liquidity situation in international markets. From July 2008 to June 2009, the supply of the two main credit instruments for exporters (the Advances on Foreign Exchange Contract and Advanced Payments method) decreased by over 25%, while their spread rates reached historical highs, remaining at those levels even after the quick recovery in export prices. Meanwhile, the supply of traditional credit designated to the overall corporate sector increased by over 20%.

The episode, therefore, arguably provides a natural experiment for testing firms' funding constraints. As we are mostly interested in studying the role of firms' funding conditions in mitigating or worsening the impact of the crisis on investment, our empirical approach starts by pairing export-intensive firms with their domestically oriented counterparts based on specific characteristics (size by number of employees and total asset value within the sector).

With this intent, we employ a dataset compiled by the Brazilian Internal Revenue

Service (IRS) over the 2007–2013 period, which includes 32,737 firms, mainly medium-sized private ones, in 18 different sectors. Only 220 of these could be considered export-intensive firms in 2008, and they constitute the "treated" group in this study.[1] Nevertheless, the large proportion of domestically oriented firms allows us to construct a control group that serves as a good counterfactual that is built by pairing firms in the two groups based on sector classification and size characteristics.

Thereafter, to address endogeneity concerns, we combine matching and the difference-in-differences (DID) approach by estimating a weighted fixed effects model with interactions between the treated group and time dummies. Additionally, we employ traditional time-varying control for investment opportunities. The results from these regressions can be interpreted as causal effects if the treated status (being export-intensive in 2008) is strictly exogenous to the shock.

The findings of this study strongly suggest that financial constraints play an important role in shaping investment decisions of Brazilian exporters during global trade turmoils: (i) the relationship between cash flow and investments is, although rather low overall, positive and statistically significant to all firms; (ii) in years of greater macro stability, the difference in exporters' funding shortages compared to those of market peers is not significant, while this difference became large and significant in 2009, during the trade collapse. A number of placebo tests suggest that our inferences are not confounded with other factors. To the best of our knowledge, this is the first paper to address the "Global Trade Collapse" episode as a possible shock to credit markets in Brazil.

This work unfolds as follows. Section 1 reviews the background literature in corporate finance regarding the relationship between investment and cash flow. Section 2 provides an overview of Brazilian credit markets for exporters and the aftermath of the Global Trade Collapse for the sector. Section 3 introduces the methodology used to estimate the regressions. Section 4 describes the data and presents some descriptive statistics. Section 5 presents the empirical results. Finally, the last section discusses the results and future investigations.

2 Literature Review

The analyses of theorists regarding the importance of a firm's financial structure for investment have their origins in the neoclassical theory of investment, developed by Modigliani and Miller (1958). Their work highlighted the irrelevance of capital structure and financial policy for real investment under perfect market conditions.[2] In our bewildered

[1] Export-intensive firms are defined here as firms that obtain at least 10% of their total revenue from exports.

[2] The Modigliani-Miller Theorem (Modigliani and Miller, 1958) states that in efficient markets with information symmetry and no transaction costs, investments are not affected by the capital structure of

world, however, a variety of distortionary forces operating in actual business cycles, such as informational asymmetries and agency problems, rule out the applicability of the presumption of financial independence.

A vast literature explores these forces on the economy, more specifically, seeking to explain the effects of market frictions on the corporate sector's investments. As presented in the forthcoming sections, different authors have addressed the existence of financial constraints and their diverse impacts on investments. The first strand of the literature touts a link between internal funds and investment spending. However, a second strand disputes this correlation, arguing that it suffers from omitted variable bias. The authors in the latter strand instead observe the responses of investment and other corporate variables to exogenous shocks on the supply of funds.

Our study unites these two research agendas. To the best of our knowledge, it is the first to combine a large-sample estimation investment – a cash flow model that uses the credit market disruption during the 2009 Global Trade Collapse as an exogenous shock to exporters.

2.1 Investment-cash flow sensitivities model

The work of Fazzari *et al.* (1988) (FHP) was the first to empirically test the role of information problems in firms' supply of credit using disaggregated data. Their seminal paper analyses the influence of financing frictions on corporate investment by comparing the empirical sensitivity of investment to cash flow (their proxy for net worth) in three different groups of firms that were divided according to their dividend payment yields (high, medium, or low). The results showed that investment in the low dividend yield group was much more sensitive to cash flow, which was interpreted as evidence of financial constraints: firms paying low yields do so because they want to retain internal funds. After all, self-funding is "free", while raising debt or equity requires a premium.

Kaplan and Zingales (1997) later questioned the robustness of the FHP model by revisiting the sample used for estimation and analyzing firms' annual reports. Based on their interpretation, contradictorily to FHP findings, firms with greater cash flow sensitivity were less likely to need external funding. In the following subsections, we will discuss the main issues plaguing the cash flow sensitivity model and the subsequent literature that attempts to overcome them.

2.1.1 Sorting criteria

Investment-cash flow sensitivity models regularly assume that, by a firm's actions (such as not paying dividends) or characteristics (being young, small, low-leveraged, or

the firm.

without a credit rating), it is possible to infer about their dependence on credit to make new investments. This is the reason why the empirical strategy to define groups of firms as "constrained" or "unconstrained" at a certain point in time often starts with an *a priori* classification of firms according to measures assumed to be correlated with information costs.

The use of this method is controversial. On the one hand, based on a survey containing a large number of questions regarding the nature and severity of obstacles encountered by firms around the world, Beck *et al.* (2006) have demonstrated that size, age, and ownership can be reliable predictors of financing obstacles. For Farre-Mensa and Ljungqvist (2016), on the other hand, some popular measures employed, such as dividend payment policy and credit rating status, as well as compound indices, are inaccurate.[3] In their sample of listed firms, those defined as "constrained" by these criteria do not behave as such: they are able to increase their leverage significantly when their demand for debt increases exogenously; they are not sensitive to exogenous variation in the supply of bank loans, and they do not tend to pay out shareholders' proceeds from equity issues.[4]

Clearly, although this strategy is analytically convenient, it is feasible that, in reality, firms switch between being "unconstrained" and "constrained" as their financial situation changes. In particular, changes in net worth value, investment opportunities, and accumulated liquidity can have a marked impact on their ability to raise external funding (HUBBARD, 1997). The severity of agency costs, for instance, might fluctuate as a firm's net worth changes, altering the length of the horizontal segment of the supply-of-funds curve.

2.1.2 A proxy for internal sources of finance

A firm's internal net worth cannot be directly calculated using balance sheet data. This brought the need to find proxies related to its "funding capacity", *i.e.*, disposable cash or collateral assets that can back external financing. Cash flow is the most commonly used proxy in the literature. Although not very precise, because it may also reflect strategic accounting decisions (timing and financial) not correlated with net worth, cash flow is the only available proxy in most cases (HUBBARD, 1997).

Some alternative proxies include the amount of short-term securities at the beginning of the period, total debt as a fraction of total assets, and short-term debt as a fraction of short-term assets.[5] However, all of these proxies (including cash flow) have the

[3] Indices that measure the degree of financial constraints – such as those of Kaplan-Zingales, Whited-Wu, and Hadlock-Pierce – are beyond the scope of this work. See Farre-Mensa and Ljungqvist (2016) for references on the subject.

[4] The firm-level data are taken from the World Business Environment Survey (WBES), which is a major firm-level survey led by the World Bank and conducted in 1999 and 2000 in 80 developing and developed countries around the world.

[5] See Vermeulen (2002) for a complete review of these alternative proxies.

same limitation: they measure the book value rather than the market value of a firm's internal sources of finance. Hence, no proxy can guarantee a correct measurement of the effects of economic shocks on firms' internal sources of finance.

The recent literature has sought to find exogenous instruments to measure internal net worth using shocks to cash and collateral that are not correlated with returns on investment. The basic idea is to find natural experiments in which specific changes in the cost of finance can be identified (LAMONT; POLK; SAAÁ-REQUEJO, 2001). This approach will be discussed in further detail in Section 2.2.

2.1.3 Investment opportunities proxies

Fazzari *et al.* (1988) acknowledged that shocks to cash flow can have a dual effect: an instantaneous increase in funding and a potential improvement in future profitability. The major concern was that Tobin's Q, the control variable in their model, would only capture outsiders' evaluations of future opportunities, while cash flow may affect investment simply because it is correlated with the insiders' evaluations of opportunities, a critical measurement error for the model (GUARIGLIA, 2008).

Moreover, an appropriate measure of investment opportunities would capture the firm management's expectations regarding the present value of future profits via additional capital investment. The value of marginal Q is clearly the variable that best suits this definition. However, its use in empirical models has been criticized because what can be constructed using real data (average Q) is equivalent to what in theory reflects investment opportunities (marginal Q) only under strong assumptions (GILCHRIST; HIMMELBERG, 1995; ERICKSON; WHITED, 2000; HAYASHI, 1982).[6] In the real world, imperfect competition and the interrelationship of firms' investment and financing decisions would violate these assumptions.

For these reasons, one part of subsequent related papers explored the need to find control variables that are capable of overcoming possible measurement error issues in proxies for investment opportunities. Almeida and Campello (2007) examined the role of asset tangibility in the firm's ability to obtain external resources and propose a new identification strategy: if firms are financially constrained, investment-cash flow sensitivities should be increasing in the tangibility of firms' assets. Carpenter and Guariglia (2008) included the firm's contractual obligations for new projects as an additional proxy, which would capture information about opportunities available only to insiders and thus not measured in Q.

[6] Hayashi (1982) demonstrated that marginal Q is equal or proportional to average Q based on the following assumptions: (i) production and adjustment cost technologies are linear homogeneous; (ii) investment and capital are homogeneous; and (iii) perfect competition exists.

2.1.4 The "fading sensitivity" issue

Recent studies employing the FHP model for samples over long time spans have shown an uncanny trend: the decline and disappearance of investment-cash flow sensitivity over time. Some authors with rather optimistic views offer two possible explanations for this "development": improvement in informational efficiency of capital markets and an increase in the supply of funds to capital markets, resulting in easier access to external capital, especially for small high-growth firms (ALLAYANNIS; MOZUMDAR, 2004; AĞCA; MOZUMDAR, 2008).

All these hypotheses might sound unrealistic if one believes that financial constraints have not disappeared. More plausibly, the changing composition of investment, especially the decreasing importance of physical investment, is responsible for this reduction in investment-cash flow sensitivity (BROWN; PETERSEN, 2009). Additionally, many authors agree that this decline can be partially explained by the measurement errors previously presented.[7]

Consistent with this view, Chen and Chen (2012) found that the information content in cash flow regarding investment opportunities has declined over time, as evidenced by declining patterns in the correlation between cash flow and Tobin's Q. Additionally, cash flow has become less persistent. As the model's efficiency issues cannot solely justify these patterns, economic or financial reasons that may explain them remain undiscovered.

2.2 The search for shocks

Perhaps the clearest evidence of the effect of financial factors on corporate behavior comes from a series of "natural experiments" capable of isolating shocks to firms' financial positions from their investment opportunities. A growing trend in the literature is to delve into events that could provide resourceful identification strategies to measure the impact of credit constraints on investments. Within the business cycle, they can arise either on the demand side, with a disruption in internal net worth, or on the supply side, with a disruption in debt and equity finance markets.

2.2.1 Early evidence

The link between credit shrinkage, capital structure and investment decisions was first established by the empirical work of Bernanke, Lown and Friedman (1991). Most of the early studies, however, did not manage to adequately isolate supply shocks from demand factors and vice versa. These studies were subjected to the standard criticism of cash flow sensitivity models regarding their use of firm-level variables: the inability to

[7] Allayannis and Mozumdar (2004), Ağca and Mozumdar (2008), Brown and Petersen (2009), Chen and Chen (2012) all mention how Tobin's Q and cash flow measurement errors help explain the decline in investment-cash flow sensitivity.

properly control investment opportunities in the event of shocks. The following paragraphs reveal some of the early strategies used in the cumbersome task of identifying shocks, both to internal and external capital, that worked in the transmission of business cycles but that were ostensibly not correlated with the expected returns of projects.

As discussed in Section 2.1, "internal net worth" implies either additional funds available for internal finance or additional collateral to back external finance. Hence, shocks on the borrower side occur through one of these two variables. Lamont's (1997) strategy was to investigate how cash shortfalls at a firm's specific division alter the shadow cost of investments in other unrelated divisions – more specifically, how the 1986 oil price decline affected oil companies in their "non-oil" segment. These results were further generalized to other industries, compiling evidence of an active capital market within corporations (HOUSTON; JAMES; MARCUS, 1997; SHIN; STULZ, 1998). However, these cross-subsidization studies require methodological caveats regarding selection biases: their experimental designs posit that divisions of multi-industry firms are randomly allocated, but firms from different divisions can feasible share common influence factors, such as exposure to the same regional economic conditions, which would invalidate this hypothesis of randomness (CHEVALIER, 2004).

Other exogenous shocks to cash might come from institutional changes in tax policies, as in Farre-Mensa and Ljungqvist (2016), or mandatory contributions to pension funds (Rauh (2006), Bakke and Whited (2012)). For collateral, land market disruptions and financial distress on market peers have been shown to influence firms' funding status. Gan (2007) explored how Japan's land market collapse during the 1990s worsened firms' debt capacities, and Carvalho (2015) studied how bankrupted firms can send negative information about their industry to investors, widely distributing valuation losses to peers and thereby amplifying downturns.

However, the studies mentioned thus far only restate the importance of internal net worth. When lender-side disruptions are analyzed, the role of capital structure in investments is shown from an alternative perspective, in essence, because they instead help identify the link between the supply of credit and corporate behavior. In this case, the challenge is to distinguish supply-side forces from demand-side ones.

A few influential papers feasibly minimized concerns about endogenous demand effects using near-concurrent events in their estimations and paired control groups. Leary (2009) used two events with opposite effects on the supply of financing: the emergence of a market for certificates of deposits in 1961 and the credit crunch in 1966. Small firms, assumed to be bank-dependent ones, are paired with others with access to public markets (the control group). Lemmon and Roberts (2010) used the collapse of leading firms in the junk bond market and the change in the credit rating guidelines in 1990 to observe changes in the investments of below-investment-grade firms, the treated group, compared to those

of unrated ones. Both papers find that the substitution of bank debt for alternative sources of capital is limited for treated firms, leaving them credit constrained during recession episodes.

As international trade shocks are more rare, studies that explore exporters' funding constraints are less common in this literature. Amiti and Weinstein (2011) uses the Japanese banking crisis in the 1990s to document how the shrinking of trade finance supply is associated with slower growth in exporters' sales. Iacovone and Zavacka (2009) employs cross-country data from several historical banking crises to show that the higher the sector's external finance dependence is, the lower its exports growth is during credit crunches.

2.2.2 Recent disruptions in Credit Markets

Given the financial origins of the 2008 crisis, several papers investigate its aftermath in terms of funding constraints and liquidity shortages. Duchin, Ozbas and Sensoy (2010) showed that corporate investment declined significantly at the onset of the crisis, especially among firms with low cash reserves or those that operate in industries dependent on external finance. Almeida *et al.* (2012) exploited the maturity structure of corporate long-term debt as an instrument for measuring financing constraints. In their view, as firms find it difficult to substitute across alternative funding sources during downturns, soon-to-mature debt might effectively reduce corporate investment. Accordingly, they find a greater decrease in investment in firms with maturity "spikes" during the crisis.

Following the failure of Lehman Brothers, concerns about the soundness of U.S. credit and financial markets led to a tightening in global credit markets. Although there is no question that demand played a part in the 2009 world trade collapse, there is increasing evidence that the liquidity contraction that rocked the financial world also contributed to the global trade shortfall. As mentioned in Bricongne *et al.* (2012, p. 134–135), "even in normal times, finance is particularly important for trade for at least three reasons: exporting entails important fixed costs such as the costs of learning about export market profitability, foreign distribution networks, regulatory compliance, etc. Second, exporting is a more risky activity than domestic transactions only. Third, exporting involves longer lags between production and delivery, with median shipment times of 2–3 months. Hence, exporters often need well-functioning credit lines to maintain healthy cash flows."

Accordingly, this recent international trade crisis has renewed academic interest in the role of credit instruments in supporting exporting activity. A recent body of evidence based on firm-level data has shown that exporters whose financial institutions had become unhealthy reduced exports more than did other firms (AHN; AMITI; WEINSTEIN, 2011). These effects were especially pronounced in sectors that require extensive external financing, that have few pledged assets, or that have limited access to trade finance (CHOR;

MANOVA, 2012). In addition, export-intensive firms' inability to use trade finance as an alternative source of finance contributed to the larger decline in sales experienced by them (COULIBALY; SAPRIZA; ZLATE, 2013).

Nevertheless, this is still a debatable matter. Levchenko, Lewis and Tesar (2011), Behrens, Corcos and Mion (2013), and Bricongne *et al.* (2012) find no evidence of the relevance of banking credit to the trade collapse. To them, the collapse was essentially a demand-driven crisis. Our work intends to be a part of this prolific literature that investigates the effects of the 2009 trade collapse. Apart from Paravisini *et al.* (2014), which uses a sample of Peruvian firms, no other paper has shown the extent to which the liquidity squeeze affected emerging-markets exporters during that period.

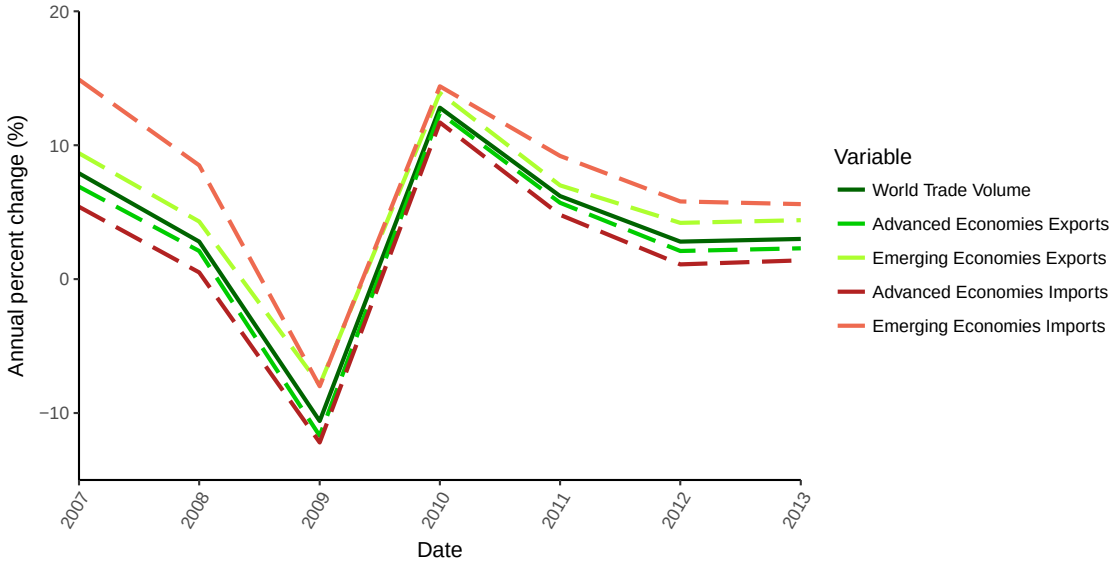
3 The 2009 Trade Collapse and its aftermath in Brazil

International trade expanded extensively over much of the past decade, boosted by globalization trends and supported by a favorable international environment, a period known as "the Great Moderation". However, as soon as the financial market bubble burst in late 2008, global trade declined significantly more than did output. From 2008 to 2009, real world GDP fell by approximately 6%, while real world trade fell by approximately 10.7, as described in Figure 1. From the earliest days of the crisis, analysts suspected that shrinking credit supply was a contributing factor to the trade collapse.

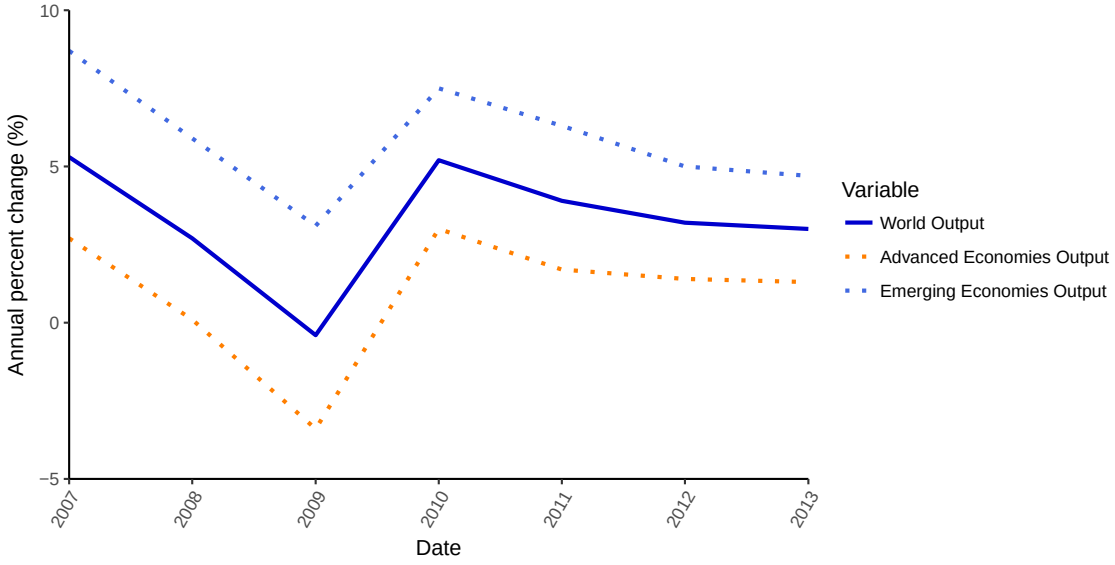
However, the negative impacts of the crisis did not reach all countries at the same time and with equal force. Hence, depending on the country and the characteristics of its credit market, the great trade collapse was associated mostly with a demand shock. From the beginning, for developed economies, the financial crisis was characterized by a severe credit crunch, as banks were unwilling to lend even to good borrowers. However, in emerging countries, the 2008–2009 Trade Collapse initially unfolded as a demand-driven shock, which harmed the productive sector relying on international markets more than others. Later, as in Brazil, greater risk aversion and liquidity concerns spread through the financial systems of emerging economies.

Figure 1 – World Outlook in 2007–2013 period

(a) Trade Volumes



(b) Output



Source: Own elaboration based on (IMF, 2010).

This section presents a brief outline of the main credit instruments available to Brazilian exporters in the 2008–2009 period. Furthermore, we explore the aftermath of the financial crisis and global trade collapse in Brazil, providing some stylized facts of that period to highlight the "Lehman link", which, by causing instability in international markets, disrupted local credit conditions for exporters. As 80–90% of world trade relies on some form of trade finance, understanding the interplay between the macroeconomic environment and the external funding supply for the sector is very important for policymakers aiming to provide the correct supply-side stimulus to spark future exporting activity (CHAUFFOUR; FAROLE, 2011).

3.1 Credit Instruments for International Trade in Brazil

Essentially, Brazilian exporters use three main credit instruments as payment methods for international trade: Advances on Foreign Exchange Contracts (ACC), Advanced Payment (AP), and BNDES-Exim, shown in figure 2. Together, they make up to over 90% of the credit volume designated to exporters in the country (GALETTI; HIRATUKA, 2013). They are among an exporter's most vital resources to succeed in foreign markets, offering customers attractive sales terms and providing firms with enough resources to finance their working capital and investments.

The ACC was the most used credit type between 2008–2013. It consists of a prepayment of resources in the national currency (BRL) to the exporter, made by a financial institution, before the good is shipped. It provides immediate acquisition of the local currency for the exporter to finance the production of goods but maintains its debt with the financial institution in dollars; the revenue from its sales also continues to be in dollars, eliminating any exchange rate risk. The ACC funds are raised abroad by resident banks operating in Brazil. Their loan interest rates usually follow international levels, which are often low by Brazilian standards. The flexibility of guarantees and terms also makes this instrument the most democratic one, helping companies of all sizes and in all sectors to export.

The second most important instrument is the AP, which relies entirely on credit concessions from foreign bank agencies. Brazilian banking institutions act as mere service providers in this funding process, not as an intermediary (as in the case of the ACC). For the exporter, the AP also differs from ACC in terms of maturity: while ACC maturity is one year at most, AP average maturity is two to three years (ROSSI; PRATES, 2010).

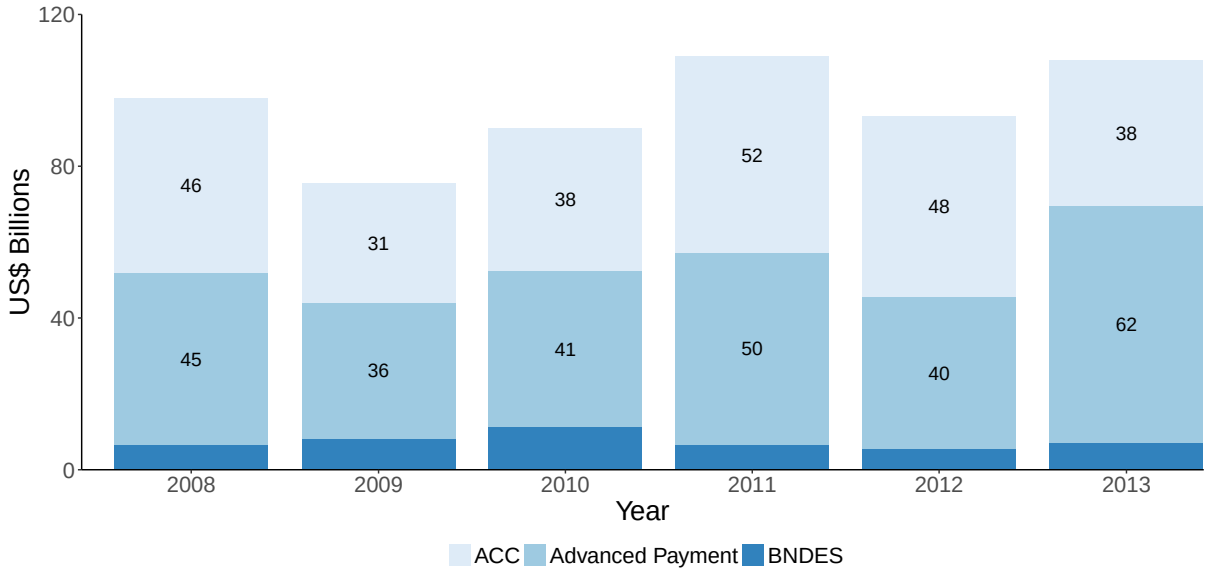
The last and least relevant of the credit instruments comes from public sources: the BNDES-Exim. This credit line has a countercyclical demand that is highly influenced by the other two instruments. Although its cost in relation to ACC and AP varies by sector and firm profile, the BNDES-Exim has the disadvantage of taking longer periods for line approval than the others. Additionally, strict requirements in terms of credit guarantees and collateral often hamper its acquisition by small and medium-sized companies.

3.2 Macroeconomic Environment

Figure 3 depicts the evolution of total exports in the 1997–2013 period, and Figure 4 its prices index. From 1999 to 2009, Brazilian exports were on the rise, in both price and volume, and this trend intensified by the 2000's commodities boom. In 2009, when world trade experienced a sudden synchronized collapse, exports' volume and aggregate prices felt more than 20% in a year.

This trade downturn was only a temporary setback limited to 2009. In 2010,

Figure 2 – Main Credit Instruments for Exporters (US$ bn)



Source: Own elaboration based on BCB and BNDES data. Note: After 2009, Brazilian export sales bounced back, reaching record highs, but the volume of credit hired was lower than pre-Lehman levels.

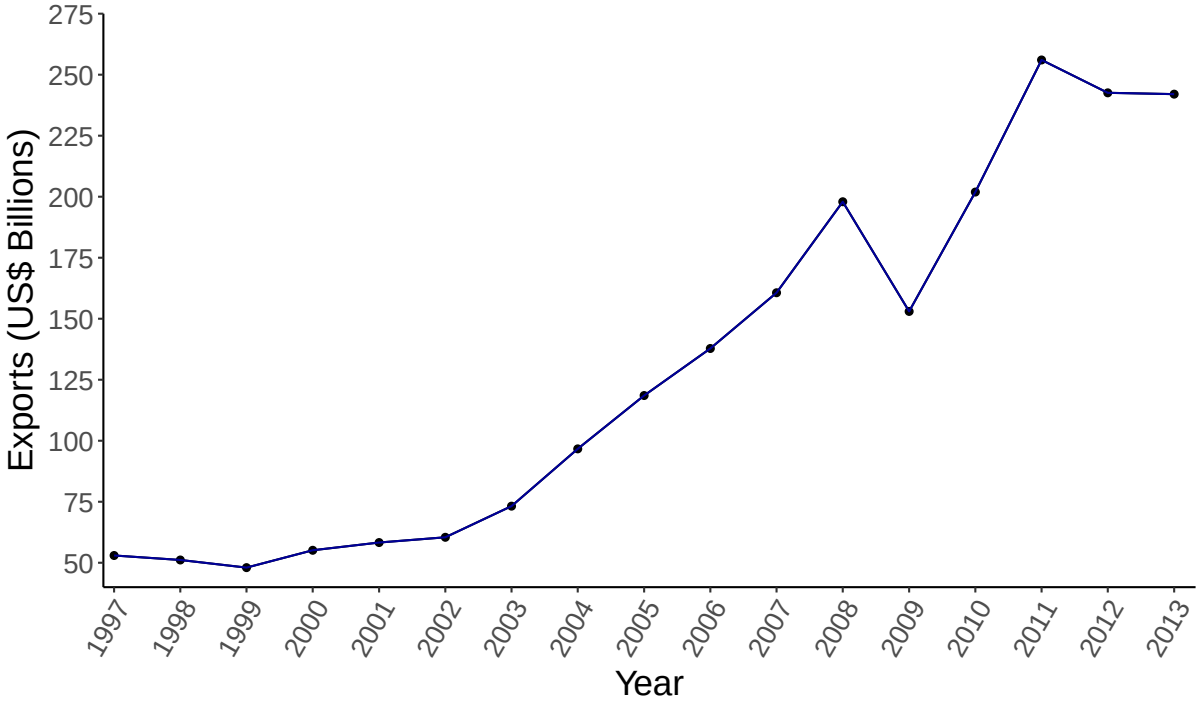
trade figures rebounded and exceeded 2008 levels in terms of volume. The exports record, however, stood in contrast to the sluggish recovery in credit market conditions for exporters. The cost of credit letters and other similar instruments in the years following the crisis remained higher than those in the pre-Lehman period. The ACC spreads, for instance, depicted in Figure 5, declined slowly over the next two years of the crisis, returning to pre-Lehman levels only by the end of 2011.

Although the Brazilian corporate sector was not immediately affected by any banking system instability at the beginning of the crisis, negative effects were felt via indirect channels. The most pronounced one was the decline in international demand. However, the Lehman Brothers collapse served as a wake-up call for the Central Bank and the federal government to intervene. The Brazilian Central Bank (BCB) was the first compelled to intervene because the episode triggered an increase in the cost of credit instruments for exporters.

In September 2008, the average interests rates for the ACC reached more than 10%, after not being much higher than 6% throughout 2007. The BCB promptly reacted with US dollar auctions to banks in an effort to provide funding for trade finance. Financial institutions who won the bids were entitled to receive dollars for its ACC and ACE from the BCB in advance, which was much-needed relief for constrained exporters.

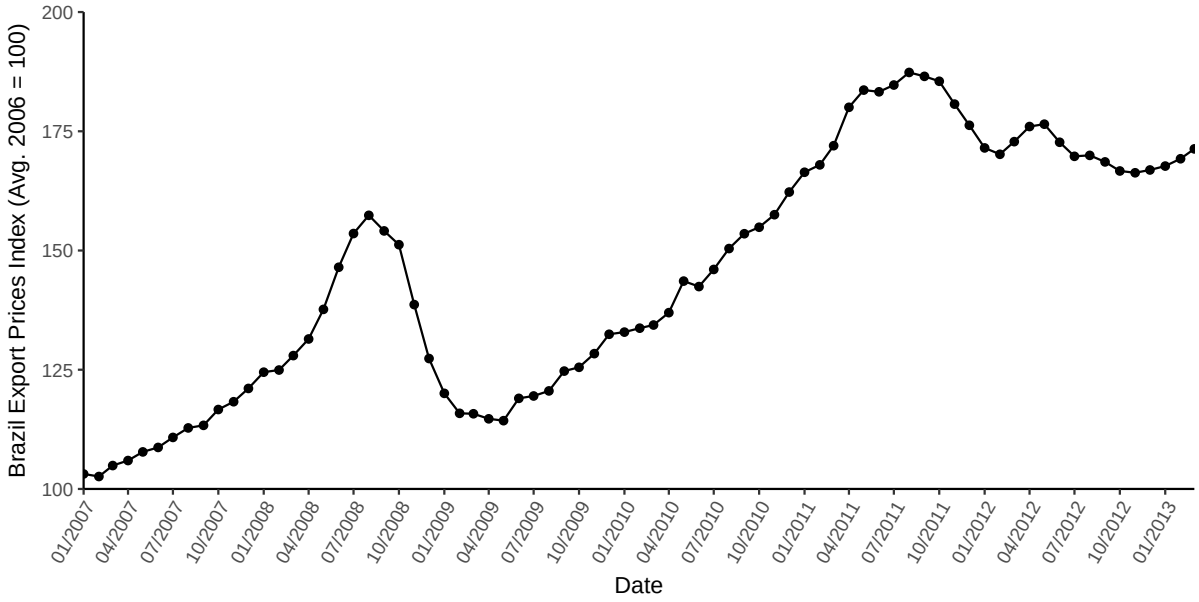
Credit markets were responsive, but the policy's effect was brief. After a few months, the countercyclical policy was offset by banks' greater risk aversion. The endorsement of more stringent credit criteria and capital allocation restrictions diminished credit lines for exporters, while ACC spreads kept rising, as shown in Figure 5. For companies, the

Figure 3 – Brazilian Exports Volume, 1997–2013



Source: Own elaboration based on Ministry of Industry, Foreign Trade and Services official data: <http://www.mdic.gov.br/index.php/comercio-exterior/estatisticas-de-comercio-exterior/series-historicas>. Note: Total export values in US$ FOB.

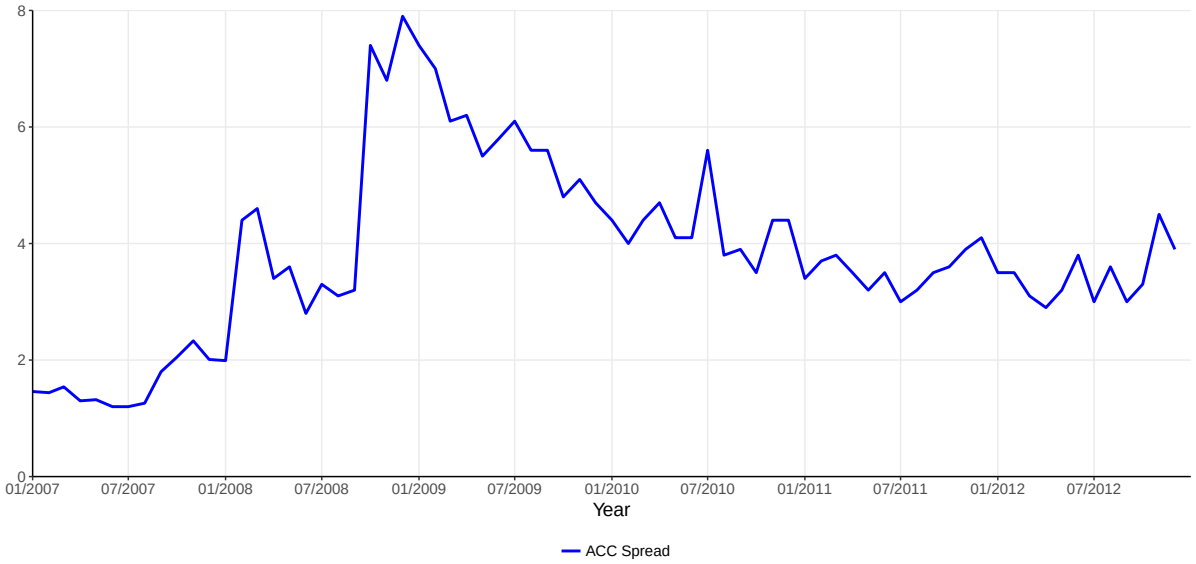
Figure 4 – Brazil Export Prices Index, 2007–2013



Source: Funcex

higher cost of funding presented the challenge of substituting external sources of funding for internal ones.

Figure 5 – Average Spread for ACC (p.p.)



Source: BCB. Note: In addition to the LIBOR, banks charge a spread for ACC contracts. The spreads rallied after the Lehman bankruptcy announcement in September 2008, later declining with the BCB's dollar auctions, and they never returned to pre-Lehman levels.

Despite its failure, the intervention set the tone for subsequent ones. In addition to stimulating the expansion of private bank lines, public banks were responsible for counteracting the scarcity of funds. During 2009, the federal government increased the amount of Treasury funds transferred to BNDES to finance exporting activity. The expansion occurred for both production (Pre-Shipment Line) and commercialization (Post-Shipment Line), totaling US$ 8.3 billion disbursed by the bank. However, this amount was less than 15% of the total credit extended to exporters. Exporters' major liquidity providers, AP and ACC, both decreased in 2009 and did not recover in 2010, even after export sales bounced back.

In the domestic backdrop, between 2003 and 2015, Brazil experienced a credit-easing cycle defined by relative economic stability. This expansion in the availability of resources started with non-earmarked credit to households. As a countercyclical policy to reduce the effects of the financial crisis, public banks increased corporate sector lending only in the 2007–2008 period. Consequently, total credit extended to the nonfinancial sector increased from 19% of GDP in 2007 to 27% GDP in 2012. For the exporting sector, however, the special requirements of its credit instruments, the dependence of the international market on the determination of interest rates, and even the direct dependence of international funds made creating specific countercyclical policies more difficult.

In this regard, this temporary setback arguably meant a cash flow shock to exporters only. However, does this natural experiment truly translate into changes in the cost of finance for the corporate sector? When investment opportunities are controlled for, were

exporting firms more or less constrained than their peers at the time? Our work attempts to identify this heterogeneity in credit constraints in the corporate sector during the Global Trade Collapse in 2009.

4 Estimation Methodology

Our basic aim is to exploit how the rising in the cost of credit to exporters at the onset of the 2009 Global Trade Collapse translated into real credit constraints for this group of firms. This study's identification strategy starts by designating the group of interest, i.e., the type of exporter belonging to the "treated" group in this analysis. It is natural to assume that the greater is a firm's dependence on foreign markets, the greater its reliance will be on credit instruments to ease liquidity issues in exporting markets. Therefore, it would be naive to include all exporting firms in this treated group. Instead, we choose to include only export-intensive firms, defined here as firms that obtained at least 15% of their total revenue from exports in 2008, at the onset of the crisis. Firms' classification groups are defined as follows:

Table 1 – Exporting Criteria

Category	Exports-to-sales ratio
Non-exporters	0%
Export-intensive firms	Greater than 15%

It is necessary to account for the fact that exporting firms potentially have specific observable characteristics underrepresented in the sample. Given the size and heterogeneity of the sample, the best strategy is to look for control units, the non-exporting firms, that can "match" the exporting ones via multiple features (covariates). More specifically, we employ the nearest neighbor matching estimator to a vector of exogenous covariates across treated and nontreated firms to find matched control firms and to estimate their weights.

Further, to establish a causal effect between financial structure and real investment, we employ a weighted linear regression, with the weights previously found in matching and accounting for unobservable fixed effects. As we are mostly interested in studying credit constraints, the outcome regression must focus on the causal effect of this cash flow variation on investment spending. The model has the following specification:

$$\begin{aligned} Investment_{i,t} = \beta_0 + \sum_{t \in Years} \overset{t}{\beta}_1 Treated_i * Year_t + \beta_2 CashFlow_{i,t}/K_{i,t-1} \\ + \sum_{t \in Years} \overset{t}{\beta}_3 treated_i * Year_t * CashFlow_{i,t}/K_{i,t-1} + \beta_4 \Delta Sales_{i,t-1} \\ + v_i + v_t + \epsilon_{i,t} \end{aligned} \tag{1}$$

where $Investment_{i,t}$ is the investment of firm i at time t, proxied by the annual variation of fixed assets, divided by fixed assets in $t-1$ to eliminate size effects from our variable. The definition of investment diverges in the literature between the use of net change in tangible fixed assets, i.e., property, plants, and equipment, and net change in total fixed assets. In this study, we chose the latter, which includes the variation of intangibles and R&D expenses, as we are addressing sectors that differ considerably in the use of tangible assets.

The independent variable, $CashFlow_{i,t}/K_{i,t-1}$, is the ratio of cash flow (net profits plus depreciation) in t over fixed assets in $t-1$, which is the classic measure of the availability of internal funds, i.e., the amount of resources left after the firm financed all its projects during the period. In the presence of imperfections in the credit market, the estimated β_2 should be positive and statistically significant if the firm's investment is sensitive to the generated cash flow. Similar to the original FHP accelerator model, in order to control for investment opportunities, $\Delta Sales_{i,t-1}$ is added.

Additionally, because the effects of the crisis and the credit market's interventions are of great interest here, we combine interactions between the treated group with the year dummy ($Treated_i * Year$) and the cash flow continuous variable ($Treated_i * Year * CashFlow_{i,t}/K_{i,t-1}$). If the coefficient of the last interaction (β_3) is somewhat larger/smaller for the treated group, it means that exporters faced different credit conditions at the time.

The error terms include three components: v_i is the firm-specific fixed effect; v_t is the time dummy set controlling for possible changes in the macroeconomic environment of each year; and $\epsilon_{i,t}$ is the firm's idiosyncratic component. Further, robustness and placebo tests provide enough confidence in the validity of this identifying assumption.

5 Data Overview and Matching

5.1 Data

We employ a unique dataset drawn from annual tax return reports filed by firms based in the state of Sao Paulo (which accounts for almost half of the companies in Brazil) over the 2007–2013 period. These reports were compiled by the Brazilian Internal Revenue Service (IRS) data systems. According to Brazilian fiscal legislation, tax return reports with complete accounting information are only mandatory for companies with gross profits over 6.5 million reais (approximately US$2MM). Therefore, some of the small firms in the state are not included in this sample.

Following the literature, firms with fewer than 50 employees were removed, as well as firms that lacked complete records of the main regression variables. Observations

with negative sales were also excluded. To control for the potential influence of outliers, we excluded observations whose capital expenditures (investment) and sales increased or decreased by more than 100%. Finally, for the ratio of cash flow to fixed assets – our main independent variable – we excluded only extreme values, which are more likely to be reporting mistakes than genuinely extreme results.[8]

The final dataset covers 27,823 different firms, which correspond to 131,067 firm-year observations, as presented in Table 2. This unbalanced panel has observations ranging from a minimum of 20,220 in 2013 to a maximum of 21,378 in 2011. These firms are mainly unlisted and operating in 20 different sectors defined according to the Brazilian National Classification of Economic Activities (CNAE).[9] Table 2 also shows the representativeness of the sample in the overall population of firms, including the total number of firms and the number of firms defined as export-intensive.

Concerning the exporting sector, approximately 10% of the firms in the sample had some revenue from exports during the 2008–2013 period. Less than 2% could be considered "export-intensive" over this period, and approximately 0.7% could be considered "export-intensive" in 2009.[10] According to the Brazilian Institute of Geography and Statistics (IBGE) and the Ministry of Industry, Foreign Trade and Services (MDIC), an average of 252,124 firms in Brazil, 21,600 of which were exporters (8%), had more than 50 employees during the same period. [11]

Table 2 – Sample Size by Category

Firms	Number of Obs.	Number of Firms	Estimated Population
Total (over 50 employees)	131,067	27,823	252,124
Exporters	16,362	2,721	21,600
Export-intensive	10,852	521	-
Export-intensive in 2008	1,521	220	-

Source: CEMPRE-IBGE, Ministry of Industry, Foreign Trade and Services (MDIC), and Brazilian IRS.
Note: The number of observations and number of firms refer to the size of the sample. The estimated population refers to the overall average number of cataloged firms on the MDIC website. If a firm's exports-to-sales ratior is not revealed, determining whether it is export-intensive is not possible.

5.2 Matching Analysis

Our goal is to the test whether funding constraints at the time of a global trade crisis altered decisions related to investments. Therefore, it is necessary to develop

[8]Observations with cash flow over 100 times higher than fixed assets were considered extreme.

[9]Due to fiscal confidentiality rules, companies are not identified, and their given sectors, from the 99 divisions of the CNAE, were combined into eighteen new divisions.

[10]Export-intensive firms, as defined previously, are those that obtained more than 15% of their revenue through exporting activities during at least one year from 2008 to 2013.

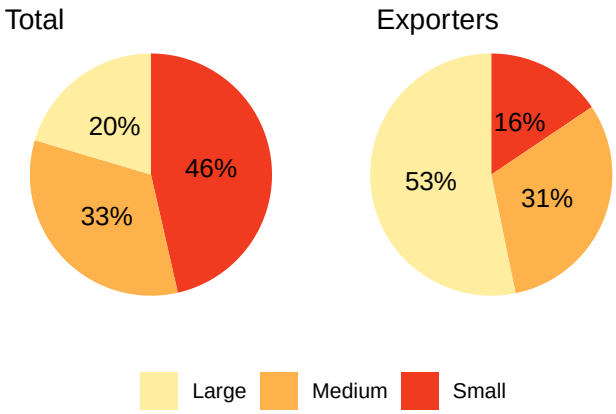
[11]The total number of firms is approximately 4.8 million, but this number includes many "nonemployee" firms, including freelance workers and individual entrepreneurs acting as service suppliers.

an identification strategy that resembles an "experiment" in which a firm's demand for these credit instruments coincides with developments in the financial market crisis. The challenge is to estimate firms' investment levels if they had not been relying on export credit lines during the financial crisis. However, since we are addressing nonexperimental data and cannot assume that firms are randomly categorized as "exporter-intensive", the best approach is to create a control group in order to later estimate the differences between the two groups in investments-cash flow sensitivity before and after the experiment.

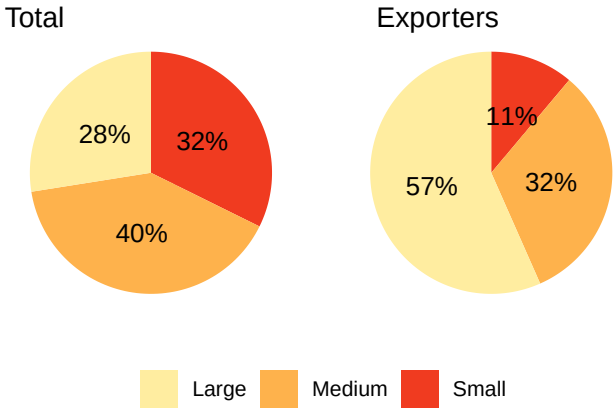
First, the construction of this control group requires a search for available covariates that are causing an imbalance between the treated and untreated groups. However, since most financial variables are reportedly endogenous to credit constraints, we rely solely on exogenous firm characteristics such as size and sector. Figure 6 displays the differences between the total sample and exporters in terms of these two attributes. The total sample comprises mostly small firms, while the exporting firms, as expected, are mainly large firms. There is also a proportional difference in terms of sector: Wholesale and Retail Trade activities are by far the most representative sector in the overall sample, accounting for approximately 50% of firms; however, this sector only accounts for approximately 13% for exporters.

Figure 6 – Total Sample versus Exporters Comparison (% by Number of Firms)

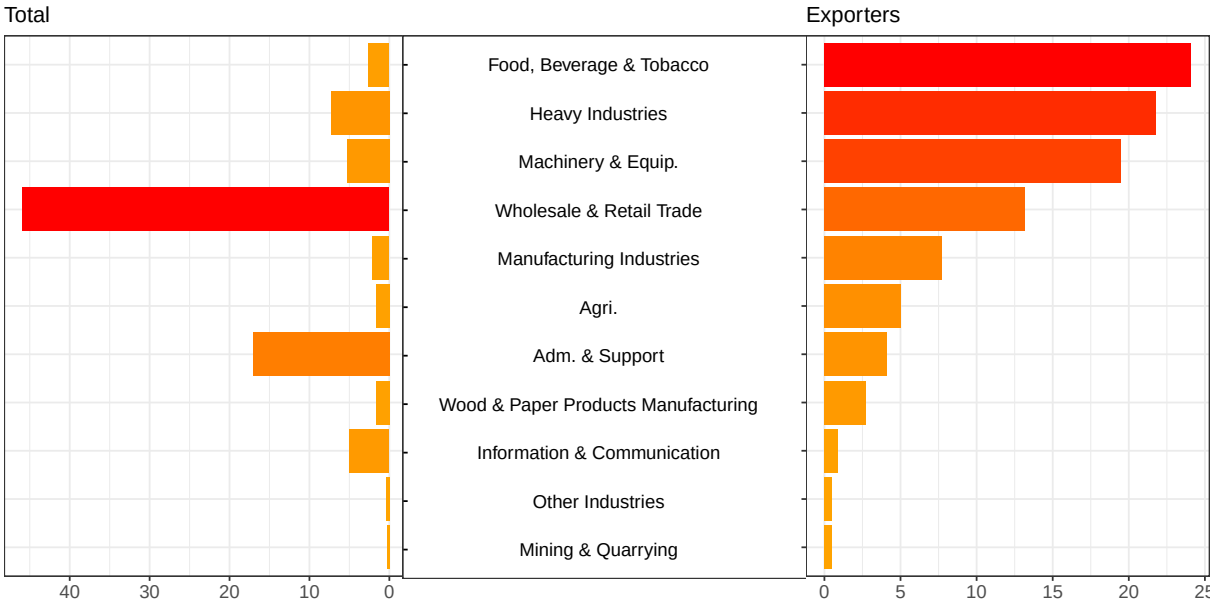
(a) Size by Number of Employees



(b) Size by Total Assets within Sector



(c) Sector Breakdown



To begin, the sample must be divided according to the firms' exports-to-sales ratio: "export-intensive" firms constitute the treated group, and companies with no export activity

during the 2008–2013 period constitute the nontreated group. This prevents companies near the 15% threshold of exports-to-sales ratio in 2008 from joining the "control" group, which would invalidate the most crucial assumption of the experiment: that firms affected by the shock are compared with those unaffected by it. Therefore, we specifically pair firms in these two groups based on their size – by number of employees (GFIP) and total assets within their sectors – and industry classification, assuming all these characteristics are constant from the year that they enter the sample throughout the analyzed period. Typically, matching is performed by pairing each participant in the control group with a participant in the treated group. However, because the size of the nontreated group is over 50 times larger than the size of the treated group in this case, we opted for 1-to-4 matching. Having more individuals from the control group matched to each individual in the treated group generates better estimates for the counterfactual.

The nearest neighbor matching estimator is used to minimize the distance between a vector of observed covariates across treated and nontreated firms, finding controls based on matches for which the distance between vectors is the smallest. As shown in Table 3, there is an improvement in the similarity of the two groups after the match. The standardized differences distance between them (a size comparison of the two means divided by their pooled standard deviation) determines the effectiveness of the matching.

Table 3 – Balance Summary

Panel A - Balance for all data:

Covariates	Std. Diff. (Cohen's D)
Size - Assets within Sector	96.83
Size - GFIP	135.25
Sector	63.73

Panel B - Balance for only matched data:

Covariates	Std. Diff. (Cohen's D)
Size - Assets within Sector	40.89
Size - GFIP	33.62
Sector	17.83

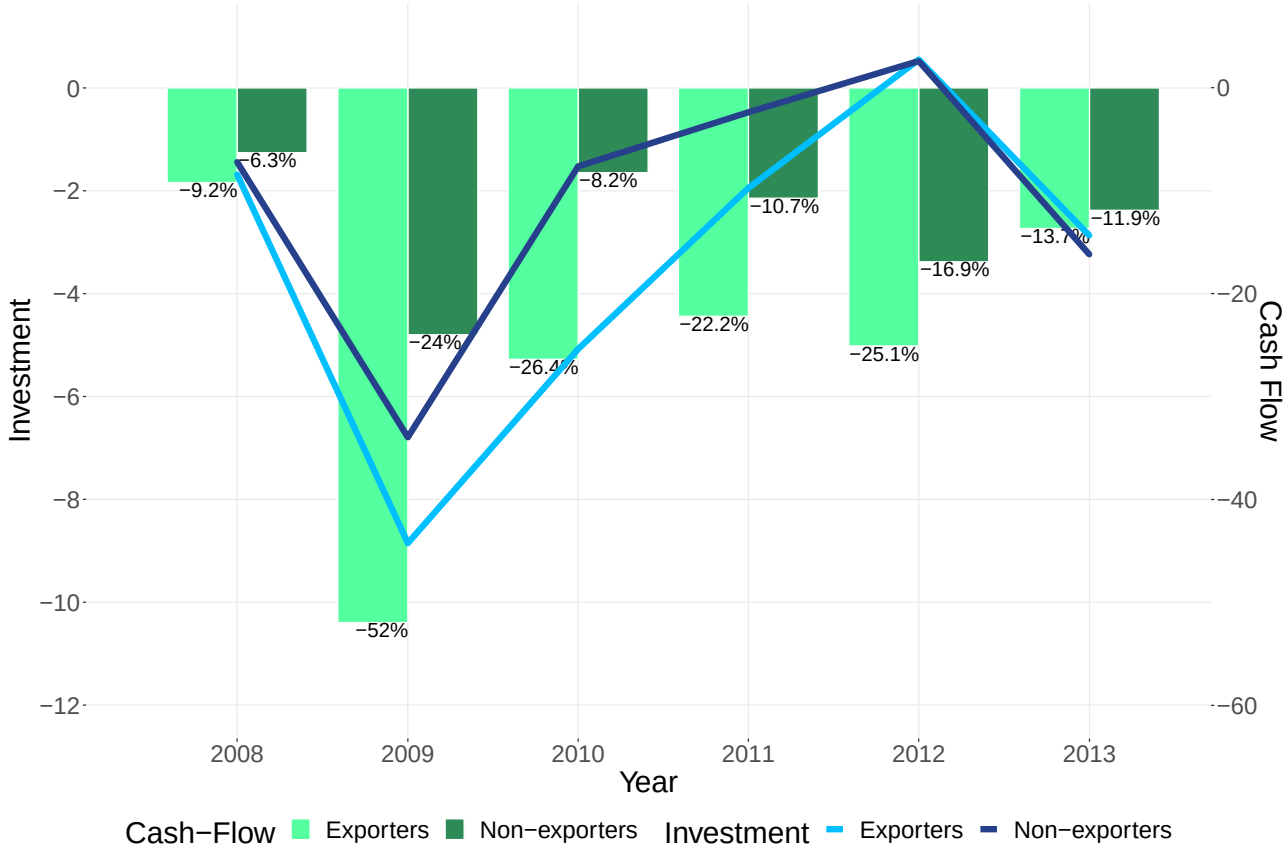
Note: The standardized difference (Cohen's D) is the difference between the means, $\mu_{Treated} - \mu_{Control}$, divided by their pooled standard deviation. A reduction in the standard difference indicates an improvement in variables' distance.

6 Results

6.1 The Investment Response

Figure 7 depicts the annual variation in the two most relevant variables of the model, investment and cash flow, for the matched sample. In 2009, exporters' cash flow decreased for the second consecutive year, and their investment rates felt 8 percentage points (from minus 1 % to minus 9%), whereas non-exporters' cash flow began decreasing in 2009 and represented a less abrupt drop in investment. Due to the calculation of growth rates for assets and sales, one year of the initial sample size is lost; hence, only data from 2008 to 2013 are included.

Figure 7 – Treated and Control Groups – Investments and Cash Flow (Annual Var. % - Median)



Source: Matched sample, own data.

Table 4 shows sample means for a number of firms' variables during the period.[12] There is a clear distinction in financial distress between the treated and control group in 2008 and 2009 in terms of investment and cash flow. However, for other financial variables, such as leverage and sales, this difference is less striking, reducing the probability that preceding balance sheet concerns caused the investment reduction of treated companies.

[12]For a more detailed definition of the variables, see Appendix 1.

Table 4 – Treated and Control Groups – Variable Means

Variable	Group	2008	2009	2010	2011	2012	2013
Investment	*Treated*	0.05	-0.05	0.00	0.04	0.03	-0.01
	Control	0.05	-0.00	0.05	0.03	0.02	-0.03
	Untreated	-0.00	-0.04	-0.02	-0.02	-0.03	-0.05
Cash-Flow Growth	*Treated*	-1.33	-1.26	-0.55	-0.94	-0.83	-0.01
	Control	-0.13	-0.30	-0.76	-0.93	-0.72	-0.33
	Untreated	-0.07	-0.21	-0.08	-0.21	-0.25	-0.14
Cash Flow / Fixed Assets	*Treated*	0.28	0.35	0.16	0.46	0.13	0.02
	Control	0.37	0.63	0.56	0.49	0.32	0.13
	Untreated	0.84	0.86	1.03	1.02	0.91	0.85
Sales Growth	*Treated*	0.04	-0.09	0.04	0.06	0.03	0.02
	Control	0.06	-0.07	0.07	0.02	-0.00	-0.03
	Untreated	0.04	-0.08	0.03	0.01	-0.02	-0.03
Leverage	*Treated*	0.69	0.68	0.80	0.72	0.71	0.77
	Control	0.74	0.78	0.79	0.87	1.03	1.05
	Untreated	1.22	1.15	1.18	1.29	1.17	1.32
Colateral	*Treated*	0.31	0.31	0.31	0.30	0.29	0.27
	Control	0.28	0.27	0.26	0.26	0.25	0.25
	Untreated	0.24	0.24	0.23	0.24	0.23	0.22
Liquidity	*Treated*	0.13	0.12	0.09	0.12	0.16	0.13
	Control	0.08	0.08	0.06	0.01	-0.12	-0.07
	Untreated	-0.20	-0.17	-0.14	-0.24	-0.11	-0.22

Note: Treated observations are firms that had more than 15% of their revenue obtained through exporting activities in 2009. The control group refers to their domestically oriented counterparts, *i.e.*, firms with no exporting activity that were paired with the treated group based on sector, size by number of employees, and size by total asset value within the sector. The untreated group corresponds to the broader group of firms in the dataset.

6.2 Baseline Results

Table 5 presents the model-based estimation of equation 1. Column (1) has the estimated coefficients of the equation without any investment opportunities control. Column (2) includes this control. The cash flow over fixed assets (Cash-Flow/K) estimated parameter is significant only when investment opportunities are not controlled for. However, for the export-intensive Treated*Cash-Flow/K*Year2009, the coefficient is positive and significant in both cases, consistent with the presence of financial constraints during the Global Trade Collapse. As column (2) depicts, in 2009, for domestically oriented firms (the control group), the baseline specification indicates that a one-point decrease in the cash flow-to-fixed assets ratio would represent a 0.7% reduction in capital expenditures on average; for export-intensive firms, this value is added to the Treated*Cash-Flow/K*Year estimated coefficient. Thus, a one-point decrease in the cash flow-to-fixed assets ratio would lead to a 0.98% reduction in exporters' capital expenditures on average.

In later years, the coefficient of this interaction variable is small and not statistically significant, which suggests that exporters were more constrained than their domestic market-focused peers at the time of the trade collapse. After Brazil's external commerce recovered from the disturbance, investment became less sensitive to cash flow – the coefficients of the two groups (treated and control) are almost even in 2010, 2011, and 2012. These results provide evidence that higher spreads and credit-line drawdowns had their share of responsibility in the decline of exporters' investment spending.[13]

When subject to scrutiny, the fact that the sample has an unbalanced panel format could invalidate the consistency of the results, specifically if one argued that constrained exporters might have left the sample in 2009, whereas unconstrained ones remained because they had sufficient resources to face the turmoil. However, as seen in Table 13 in the Appendix, the data used here are characterized by their high persistence. Almost half of the companies encompassing the sample are observed throughout the analyzed period, eliminating the likelihood of having a biased treated group in the post-crisis period.

[13]A dynamic version of Equation 1 (adding the lagged dependent variable) was also estimated via the First-difference GMM (Arellano and Bond (1991)) and the system GMM estimator (Blundell and Bond (1998)). However, the results were discarded because the lagged investment variable was not significant.

Table 5 – Fixed Effects Estimation

	Dependent variable:	
	Investment	
	(1)	(2)
Treated*Cash-Flow*Year2009	0.022***	0.020**
	(0.006)	(0.028)
Treated*Cash-Flow*Year2010	0.0003	−0.0003
	(0.977)	(0.983)
Treated*Cash-Flow*Year2011	−0.005	−0.006
	(0.488)	(0.429)
Treated*Cash-Flow*Year2012	0.005	0.004
	(0.567)	(0.511)
Treated*Year2009	−0.058**	−0.056*
	(0.035)	(0.083)
Treated*Year2010	−0.053*	−0.053
	(0.060)	(0.110)
Treated*Year2011	−0.019	−0.018
	(0.514)	(0.600)
Treated*Year2012	−0.009	−0.011
	(0.752)	(0.739)
Cash Flow/Fixed Assets	0.007*	0.006
	(0.070)	(0.118)
Lag Sales		0.078**
		(0.011)
Year Effects	Yes	Yes
Individual Effects	Yes	Yes
Observations	3,912	3,260
R^2	0.262	0.311
Adjusted R^2	0.110	0.134
Residual Std. Error	0.241 (df = 3246)	0.237 (df = 2594)

Note: Columns (1) and (2) show the fixed effects regression coefficients of equation 1 first without controlling for investment opportunities and later adding *Lagged* Δ *Sales* as the investment opportunities control. Time and sector dummies were included in all specifications. Standard errors and test statistics are asymptotically robust to heteroskedasticity.

6.3 Robustness Tests

Next, three different robustness check strategies are performed (summarized in Table 6). The first one involves modifying the treated group. First, the group of "export-intensive" firms is enlarged: companies whose exports-to-sales ratio is greater than or equal to 5% are assigned to this category. Second, the treated group is reduced: the "export-intensive" group is defined as firms whose exports-to-sales ratio is greater than or equal to 25%. Only in the second case does the main variable of interest, Treated*Cash-Flow/K*Year2009, remain significant. Tables 7 and 8 present the results of these two tests.

The next test involves changing the matching ratio for the nearest neighbor matching. We perform 1-to-2 matching (every firm in the treated group must be compared with two firms in the control group) and 1-to-1 matching. Tables 9 to 10 show the results of such tests. In addition, in the third test, whose results are shown in Table 11, we include the level of the cash flow-to-fixed assets ratio in 2008 (pre-crisis) as a covariate in the matching. Our main results are robust to these two tests.

Table 6 – Robustness Tests Definition

Test 1 – Changes in treated group definition	
Smaller group	treated group defined as firms with exports-to-sales ratio over 5%
Large group	treated group defined as firms with exports-to-sales ratio over 25%
Test 2 – Changes in matching ratio	
1-to-2 matching	Every treated must have two controls
1-to-1 matching	Every treated must have one control
Test 3 - Changes in matching covariates	
Lagged cash flow adition	Matching is performed by adding the Cash Flow/K in 2008 as a covariate

Table 7 – Robustness Test 1 – Treated with exports-to-sales ratio over 5%

	Dependent variable:	
	Investment	
	(1)	(2)
Treated*Cash-Flow*Year2009	0.009	0.003
	(0.342)	(0.758)
Treated*Cash-Flow*Year2010	0.012	0.007
	(0.365)	(0.585)
Treated*Cash-Flow*Year2011	−0.008	−0.012
	(0.267)	(0.105)
Treated*Cash-Flow*Year2012	0.008	0.008
	(0.347)	(0.298)
Treated*Year2009	−0.047**	−0.059**
	(0.035)	(0.031)
Treated*Year2010	−0.056**	−0.070**
	(0.029)	(0.021)
Treated*Year2011	0.004	−0.010
	(0.869)	(0.741)
Treated*Year2012	0.028	0.012
	(0.272)	(0.683)
Cash Flow/Fixed Assets	0.010***	0.011***
	(0.000)	(0.000)
Lag Sales		0.043
		(0.117)
Year Effects	Yes	Yes
Individual Effects	Yes	Yes
Observations	6,660	6,660
R^2	0.279	0.286
Adjusted R^2	0.133	0.141
Residual Std. Error	0.234 (df = 5536)	0.233 (df = 5535)

Note: In this robustness test, the group of "export-intensive" firms is enlarged: companies whose exports-to-sales ratio is greater than or equal to 5% are assigned to this category. Columns (1) and (2) show the fixed effects regression coefficients of equation 1, first without controlling for investment opportunities and later adding *Lagged* Δ *Sales* as the investment opportunities control. Time and sector dummies were included in all specifications. Standard errors and test statistics are asymptotically robust to heteroskedasticity.

6.4 Placebo Tests

To strengthen the interpretation of the results, we construct a false treated group by randomly selecting a non-exporters subset with the same number of firms as the real treated group. This estimation was repeated several times, changing the firms selected to the false treated group. One of the results is reported below in Table 12. As expected, the estimated coefficients are insignificant for $Cash\ Flow/K$ and $Treated * Cash\ Flow/K * Year$.

7 Concluding remarks

This study provides new evidence that financial factors might have contributed to a greater decline in investments. As almost all the credit instruments designed to finance exporting activity rely on the availability of external financing in foreign currency, they are expected to be highly vulnerable to oscillations in the liquidity of international markets. Using the 2008–2009 financial crisis as a negative shock on the supply of credit to exporters, we estimate a modified version of the traditional investment regression, present in the FHP model, to show that Brazilian exporters were indeed more constrained than their domestically oriented counterparts during this episode. Notwithstanding, funding shortage differences diminish and become insignificant as markets bounced back.

Although the effects of the 2009 crisis have been extensively analyzed, only a small proportion of papers present firm-level data regarding its aftermath in emerging markets, especially in Brazil, which has little available data on private companies. Perhaps given the difficulty of creating a representative sample from our firm population, this is the first paper to gauge a causal effect between credit markets and exporters' investment behavior in Brazil. We do so by employing a unique dataset of firms, of which 220 were export-intensive firms in 2008 paired with domestically oriented firms based on several characteristics. Our findings are in line with the existing literature regarding the dependence of exporting activity on external funding (CHOR; MANOVA, 2012; AMITI; WEINSTEIN, 2011; IACOVONE; ZAVACKA, 2009). The results call on policymakers to explore the development of additional sources of financing for exporting activity, which might not be considered essential in normal times but could prove useful during crises when international credit markets become impaired.

Table 8 – Robustness Test 1 – Treated with exports-to-sales ratio over 25%

	Dependent variable:	
	Investment	
	(1)	(2)
Treated*Cash-Flow*Year2009	0.022***	0.018**
	(0.004)	(0.029)
Treated*Cash-Flow*Year2010	−0.001	−0.004
	(0.940)	(0.752)
Treated*Cash-Flow*Year2011	−0.001	−0.002
	(0.818)	(0.751)
Treated*Cash-Flow*Year2012	−0.002	−0.003
	(0.626)	(0.498)
Treated*Year2009	−0.041	−0.021
	(0.182)	(0.558)
Treated*Year2010	−0.057*	−0.039
	(0.087)	(0.297)
Treated*Year2011	0.010	0.029
	(0.746)	(0.411)
Treated*Year2012	−0.034	−0.020
	(0.259)	(0.567)
Cash Flow/Fixed Assets	0.004*	0.004
	(0.076)	(0.135)
Lag Sales		0.061**
		(0.031)
Year Effects	Yes	Yes
Individual Effects	Yes	Yes
Observations	2,796	2,330
R^2	0.258	0.317
Adjusted R^2	0.104	0.141
Residual Std. Error	0.241 (df = 2316)	0.237 (df = 1850)

Note: In this robustness test, the group of "export-intensive" firms is reduced: companies whose exports-to-sales ratio is greater than or equal to 25% are assigned to this category. Columns (1) and (2) show the fixed effects regression coefficients of equation 1, first without controlling for investment opportunities and later adding *Lagged* Δ *Sales* as the investment opportunities control. Time and sector dummies were included in all specifications. Standard errors and test statistics are asymptotically robust to heteroskedasticity.

Table 9 – Robustness Test 2 – 1-to-2 matching

	Dependent variable:	
	Investment	
	(1)	(2)
Treated*Cash-Flow*Year2009	0.022***	0.019**
	(0.009)	(0.038)
Treated*Cash-Flow*Year2010	0.00002	−0.001
	(0.998)	(0.963)
Treated*Cash-Flow*Year2011	−0.006	−0.008
	(0.419)	(0.320)
Treated*Cash-Flow*Year2012	0.004	0.004
	(0.610)	(0.568)
Treated*Year2009	−0.051*	−0.059*
	(0.082)	(0.089)
Treated*Year2010	−0.065**	−0.074**
	(0.033)	(0.039)
Treated*Year2011	−0.038	−0.044
	(0.227)	(0.224)
Treated*Year2012	−0.010	−0.020
	(0.757)	(0.585)
Cash Flow/Fixed Assets	0.008*	0.008*
	(0.052)	(0.074)
Lag Sales		0.069**
		(0.018)
Year Effects	Yes	Yes
Individual Effects	Yes	Yes
Observations	2,940	2,450
R^2	0.269	0.319
Adjusted R^2	0.118	0.143
Residual Std. Error	0.238 (df = 2436)	0.234 (df = 1946)

Note: In this robustness test, 1-to-2 matching is performed (every firm in the treated group should be compared with two firms in the control group). Columns (1) and (2) show the fixed effects regression coefficients of equation 1, first without controlling for investment opportunities and later adding *Lagged* Δ *Sales* as the investment opportunities control. Time and sector dummies were included in all specifications. Standard errors and test statistics are asymptotically robust to heteroskedasticity.

Table 10 – Robustness Test 2 – 1-to-1 matching

	Dependent variable:	
	Investment	
	(1)	(2)
Treated*Cash-Flow*Year2009	0.020**	0.018*
	(0.018)	(0.054)
Treated*Cash-Flow*Year2010	−0.001	−0.001
	(0.948)	(0.941)
Treated*Cash-Flow*Year2011	−0.009	−0.011
	(0.278)	(0.191)
Treated*Cash-Flow*Year2012	0.003	0.003
	(0.723)	(0.642)
Treated*Year2009	−0.064**	−0.073*
	(0.045)	(0.063)
Treated*Year2010	−0.082**	−0.092**
	(0.022)	(0.029)
Treated*Year2011	−0.063	−0.070
	(0.119)	(0.123)
Treated*Year2012	−0.005	−0.017
	(0.891)	(0.699)
Cash Flow/Fixed Assets	0.010**	0.009**
	(0.032)	(0.024)
Lag Sales		0.053
		(0.122)
Year Effects	Yes	Yes
Individual Effects	Yes	Yes
Observations	2,304	2,304
R^2	0.256	0.265
Adjusted R^2	0.101	0.112
Residual Std. Error	0.241 (df = 1906)	0.240 (df = 1905)

Note: In this robustness test, 1-to-1 matching is performed (every firm in the treated group should be compared with eight firms in the control group). Columns (1) and (2) show the fixed effects regression coefficients of equation 1, first without controlling for investment opportunities and later adding *Lagged* Δ *Sales* as the investment opportunities control. Time and sector dummies were included in all specifications. Standard errors and test statistics are asymptotically robust to heteroskedasticity.

Table 11 – Robustness Test 3 – Adding Cash Flow covariate

	Dependent variable:	
	Investment	
	(1)	(2)
Treated*Cash-Flow*Year2009	0.023***	0.020**
	(0.006)	(0.025)
Treated*Cash-Flow*Year2010	0.001	0.00001
	(0.960)	(0.999)
Treated*Cash-Flow*Year2011	−0.004	−0.005
	(0.568)	(0.542)
Treated*Cash-Flow*Year2012	0.005	0.005
	(0.539)	(0.482)
Treated*Year2009	−0.034	−0.046
	(0.185)	(0.113)
Treated*Year2010	−0.049*	−0.058*
	(0.079)	(0.061)
Treated*Year2011	0.029	0.017
	(0.260)	(0.552)
Treated*Year2012	0.031	0.016
	(0.254)	(0.589)
Cash Flow/Fixed Assets	0.006	0.005
	(0.127)	(0.228)
Lag Sales		0.068***
		(0.005)
Year Effects	Yes	Yes
Individual Effects	Yes	Yes
Observations	4,272	3,560
R^2	0.257	0.298
Adjusted R^2	0.105	0.118
Residual Std. Error	0.239 (df = 3546)	0.233 (df = 2834)

Note: In this robustness test, the variable cash flow-to-fixed assets ratio in 2008 (pre-crisis) is added as a covariate in the matching. Columns (1) and (2) show the fixed effects regression coefficients of equation 1, first without controlling for investment opportunities and later adding *Lagged* Δ *Sales* as the investment opportunities control. Time and sector dummies were included in all specifications. Standard errors and test statistics are asymptotically robust to heteroskedasticity.

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1 Appendix: Detailed variable definitions

Fixed capital stock (K): book value of fixed assets
Fixed investment (I): difference between the book value of fixed assets at end of year *t* and end of year *t-1*.
Cash flow (CF): net income plus depreciation.
Sales (S): a firm's total sales minus returned and canceled sales (including domestic and overseas sales).
Sales Growth: percentage of change in sales from one period to another.
Leverage: ratio of current liabilities plus non-current liabilities to total assets.
Liquidity: current assets minus current liabilities to total assets.
Collateral: tangible fixed assets over total assets.
Export Rate: ratio of exports to total sales.
Deflators: all growth variables are deflated using the Brazilian GDP Price Deflator (% YoY).

2 Appendix: Sample Profile

Table 12 – Placebo Test – Fake treated group

	Dependent variable:	
	Investment	
	(1)	(2)
Treated*CashFlow*Year2009	0.007	0.008
	(0.006)	(0.006)
Treated*CashFlow*Year2010	−0.003	−0.004
	(0.011)	(0.011)
Treated*CashFlow*Year2011	0.005	0.004
	(0.010)	(0.010)
Treated*CashFlow*Year2012	−0.014	−0.015*
	(0.009)	(0.009)
Treated*Year2009	−0.015	−0.016
	(0.031)	(0.031)
Treated*Year2010	−0.006	−0.001
	(0.033)	(0.033)
Treated*Year2011	−0.030	−0.030
	(0.033)	(0.033)
Treated*Year2012	−0.018	−0.019
	(0.032)	(0.032)
Cash Flow/Fixed Assets	0.003**	0.002*
	(0.001)	(0.001)
Lag Sales		0.088***
		(0.019)
Year Effects	Yes	Yes
Individual Effects	Yes	Yes
Observations	4,996	4,996
R^2	0.304	0.308
Adjusted R^2	0.111	0.116
Residual Std. Error	0.289 (df = 3912)	0.288 (df = 3911)

Note: The placebo test is performed with a false treated group, created by randomly selecting firms from the control group. Columns (1) and (2) show the fixed effects regression coefficients of equation 1, first without controlling for investment opportunities and later adding *Lagged* Δ *Sales* as the investment opportunities control. Time and sector dummies were included in all specifications. Standard errors and test statistics are asymptotically robust to heteroskedasticity.

Table 13 – Dataset composition by number of observations per firm

Number of obs. per firm	Number of firms	Percent
1	3,331	11.97
2	3,703	13.31
3	2,607	9.37
4	2,272	8.17
5	2,484	8.93
6	2,981	10.71
7	10,445	37.54
Total	27,823	100