The Determinant Factors of Hedging and Speculation with Foreign Exchange Derivatives of Brazilian Private Firms

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Abstract

This paper examines the determinant factors of hedging and speculation with foreign exchange derivatives of Brazilian private firms. We build an original database of 211,746 contracts of plain vanilla derivatives of foreign exchange from 2010 to 2021 of these firms. From these contracts, we identify that the most relevant factor that affects positively hedging is foreign exchange exposure, while profitability is the most important factor that affects negatively speculation. Our results are statistically significant and are robust to different specifications and econometric techniques, in particular, to those that deal with endogeneity of regressors and measurement errors of binary dependent variables.

Keywords: foreign exchange derivatives, hedge, speculation, private firms, determinant factors

JEL: G13, G32, G38

1. Introduction

Foreign exchange risk management plays a particularly key role in modern business strategy. To manage such risks, firms use worldwide foreign exchange derivatives.[1,2] For stakeholders in the firms, it is important to know the main determinants of foreign exchange derivatives demand, for what purpose firms employ them and what are the consequences of their use in terms of market value. Regulators and policy makers, as well, are concerned with the potential role of foreign exchange derivatives in broader issues of market stability.

Assets with a significant level of risk such as foreign exchange derivatives can induce cash flow fluctuations that nullify the foreign exchange risk of individual assets essential to a company's operations. We refer to this risk management strategy as hedging.

However, as Bartram (2019) stresses, derivatives can be effective tools for corporate hedging and equally well suited for speculative purposes, even under the disguise of hedging. In this respect, foreign exchange derivatives can increase a firm's foreign exchange risk, reflecting a demand for speculative reasons (Merton (1987)).

Some empirical papers in the literature have addressed the issue of whether the use of financial derivative is value-enhancing, because it reduces foreign risk exposures (in the case of hedging), or whether it is value-enhancing (in the case of speculation). Faulkender (2005) and Adam and Fernando (2012) document evidence supporting the second possibility. Bodnar (2014) shows that for 50% of 1,161 global firms, market timing is important for their demand of foreign exchange derivatives. Bodnar et al. (1998) describe that, on many occasions, firms in the United States alter the size or the timing of a hedge depending on their market view on exchange rates. Finally, Lins et al. (2011) show that close to 50% of 229 firms from 36 countries take active- in some cases speculative- positions in foreign exchange derivatives.

Firms in emerging economies are active users of foreign exchange derivatives as Liriano (2016) shows. These countries are very vulnerable to foreign exchange volatility. More

[1] The International Swap Derivatives Association (ISDA) reports on derivative use in 2009 shows that the of world's 500 largest companies, 92 report use of derivative instruments to manage business and financial risks. Géczy et al. (1997) also point that 41.4% of North American companies pertaining to the Fortune 500 group used foreign exchange derivatives in 1990.

[2] Ehlers and Parker (2013) show that foreign exchange derivatives market has grown rapidly since the 1990s mostly in the over-the-counter market (OTC).

recently, after the subprime crisis, Chui et al. (2016) show that a new dimension to currency mismatches in emerging markets has been created by policies that have increased global liquidity. Lower interest rates and a huge expansion in central bank balance sheets of industrial economies have served to ease financing conditions facing firms of emerging market economies. This has allowed these firms to increase notably their foreign currency exposures.

This situation is particularly important in Brazil, one of the largest emerging economies. Brazil has an especially important commodity export sector with extremely high levels of capital cost that lead domestic firms to seek external credit abroad. Of course, in such circumstances, understanding what the main determinants for hedging and speculation of Brazilian private firms is essential for stakeholders, regulators, and policy makers alike. To understand these determinants is the main objective of this paper.

> Not only is the demand of foreign exchange exposure important for firms, but also to policy makers in Brazil. In 09/13/2009, for example, in an interview for "Folha de São Paulo", Henrique Meirelles, which was President of Banco Central do Brasil (hereafter BCB) at the time, expressed preoccupation with the use of foreign exchange derivatives by several Brazilian firms as well to the impact that this could have on the financial market in Brazil. In the words of President Meirelles: "Large Brazilian firms had signed derivative contracts selling dollars equivalent, in some cases, to years of exports. With the exchange rate depreciation, the loss of these companies increased enormously. They became insolvent. They were big companies; you did not know how many or which. They had mostly contracted with international banks. Only they maintained lines of credit with major national banks - here, again, it was not known how many or which."[3]

Situations emblematic of this speculative posture that President Meirelles was referring to, were the cases that occurred with the companies Sadia S/A and Aracruz Celulose S/A. Sadia S/A, one of the main Brazilian food industries, and Aracruz Celulose S/A, a paper industry giant, recognized in September 2008 that they would have to compute high losses in their next financial statements due to operations carried out with derivatives of foreign exchange. At no time before September 2008, were the stakeholders and shareholders of these firms informed that they were using derivative financial instruments to leverage results. Both firms were using derivatives as financial instruments for some time and were showing relevant results

[3] Author´s translation

with their use. Such results benefited its managers, both in the form of salary rewards and the increase in price of stocks in the market. However, the objectives of its shareholders were not considered, especially minority shareholders who depend on the disclosure and transparency of standardized financial statements.

To accomplish our objective, we build an original database of 11,081 contracts of swaps of foreign exchange, 160,234 contracts of forwards of foreign exchange, 15,423 contracts of future of foreign exchange and 25,008 contracts of options of foreign exchange, open at the end of each year from 2010 to 2021 of Brazilian private firms. We complement this database with balance sheet and financial information that come from Valorpro.[4] We have a total of 8,071 firms in our sample, of which 5,503 are joint stock and 2,568 are limited liability firms.

The derivatives contracts data that we use in this study come from confidential information of Banco Central do Brasil (hereafter BCB). BCB started to collect data on nonfinancial firm's derivatives contracts after the subprime crisis, because this crisis started to negatively affect the capacity of many Brazilian nonfinancial firms to obtain external credit. BCB was worried that this could affect these firm´s cash flows, which could have negative impacts on Brazil´s financial system.

A crucial decision we make in this paper is how to define hedging and speculation with foreign exchange derivatives of firms. This definition for any firm is a very difficult task for an empiricist that only has ex-post data of this firm and that does not know the ex-ante risk strategy of this firm in the foreign exchange market.

Even so, aware of the fact that this is a very subtle and complicated issue, we define hedge and speculation based on the transaction foreign exchange exposures that firms face. These exposures can be split into two components: identifiable anticipated transactions of cash flows and competitive exposures, which are the ones related to unidentifiable future cash flows. We take in consideration in this paper the former ones. As Hagelin (2003) and Bodnar et al. (1996) argument the reason for not investigating the latter is that few firms tend to hedge this type of exposure with foreign exchange derivatives. Instead, the long-term competitive exposures are managed by operational hedges rather than financial ones.[5]

[4] "Valorpro" is a proprietary database of the newspaper "Valor Econômico". It contains real time economic and financial news as well as a database of mostly private firms with annual data from 2008 to the present.
[5] Foreign exchange derivatives are examples of financial hedges.

To define hedging and speculation for a particular private firm, we compare its net notional value of foreign exchange derivatives open at each year from 2010 to 2021 and its foreign exchange exposure in each one of these years. The foreign exposure of a firm is measured by the value in US dollars of the sum of foreign exchange debt with total imports minus total exports. Thus, our definitions of hedge and speculation are related to the transaction exposure that firms face.[6] Despite the inherent difficulty and limitations of these definitions, we do think they are the best that an empiricist can do considering data available.

Our definitions above allow for the possibility that a private firm is both hedging and speculating at the same time with foreign exchange derivatives. One example of this would be a firm with foreign exchange debt and belonging to a non-tradable sector, in which the net notional amount of its foreign exchange derivatives contracts is long in foreign exchange rate and higher than the value of its external debt. In this case, this firm may be hedging and speculating at the same time.

A casual observation of our data, using our definitions of hedging and speculation, shows that 206 firms (5.81%) hedged, while 1,213 private firms (15.02%) speculated in our sample period. The great majority of firms that hedged 66 firms (32.03%) and speculated 508 firms (41.08%) came from the industrial sector. In the case of firms that hedged, we verify that most of them had external debt, 222 firms (98.54%). In the case of speculation, most of them, 1,043 (85.58%) had no foreign exchange exposure. This last observation is particularly striking, because it is important evidence that private firms in Brazil demand foreign exchange derivative to obtain financial gains, independent of their core businesses.

Our main econometric analyses are based on Pool of Cross Section Probit Models, in which the dependent variable is equal to one if the firm hedged or speculated in our sample period and zero otherwise. The explanatory variables are the ones related to foreign exchange exposure of private firms and other control variables that theory points out as the most important to understand the decisions of hedging and speculation with foreign exchange derivatives.[7]

[6] In addition to transaction exposures, the literature studies translation exposures. These exposures arise as the financial accounting statements of foreign affiliates are translated into the currency of the parent firm. The general recommendation of the corporate finance literature is not to worry about this type of exposure and thus not to hedge it (see Hagelin(2003)).

[7] See Spanò (2012) for a good survey on the determinant factors of hedging and speculation with foreign exchange derivatives.

Our results indicate that that the most relevant factor that affects positively hedging is foreign exchange exposure, while profitability-measured by the ratio of Ebitda and total assets and growth opportunities measured by the ratio of operational reserves and total asset- are the most crucial factors that affect negatively speculation. Our results seem robust to different specifications and econometric techniques in the case of the latter, to techniques that deal with endogeneity of regressors and measurement errors of binary dependent variables.

Despite its significant importance, the empirical literature that examines the determinant factors of the demand of foreign exchange derivatives, separating hedging from speculation motives, is scarce. Some of this literature focuses whether the use of derivatives is consistent with existing theories of hedging and other with theories of speculation. In the case of the former, examples are Tufano (1996), Geczy et al. (2007), Haushalter (2000), and Graham and Rogers (2002). In case of the latter, one example is Geczy et al. (2007).

The problem of this empirical literature is the fact that the classification of hedging and speculation of firms with foreign exchange derivatives is done by looking at firm´s annual reports or firm´s responses in surveys.

The big disadvantage of surveys is that is difficult to get the accurate information or data about the firm's derivatives position, because managers of some firms do not want to disclose their motivation or determinants of derivatives usage, because they do not want to leak the information to their competitors.

In the case of annual reports, the International Financial Reports Standards, which is used in a vast number of countries nowadays, obliges firms to disclose whether they use foreign exchange derivatives or not and if their purpose is for hedging or trading. At the same time, firms must report the information about the whole range of the foreign exchange risk they face in their business operations and the activity they take to handle these risks. The quantitative information about the firm's risk and the financial instruments make it possible for readers of financial statements to interpret the foreign exchange risk, which firms face in their business activities. However, very few firms report the notional amounts of foreign exchange derivatives and their net positions- long or short in foreign exchange rate, which creates relevant information gaps.

Due to these information gaps, it is hard to distinguish hedging from speculation. This is even more noticeable in the case of private firms, because not all of them are obliged to disclosure

their balance sheets and financial information in details, like listed firms have to do. Therefore, the power of the statistical tests used in most studies of foreign exchange derivatives use could be curtailed by the lack of detailed and granular data. This makes the tests and results so far of this empirical literature noisy and hard to interpret. [8]

We think that a major contribution of our paper is precisely improving on the classification of speculation and hedging with foreign exchange derivatives, to what has been done so far in the empirical literature. Our database of foreign exchange derivatives contracts provides means to identify, in a more accurate manner, hedging and speculation done by firms, without the need to resort to annual reports or surveys.

The reason is that we look directly at the open foreign exchange derivatives contracts of private firms at the end of each year of our sample period and know, exactly, what is their net notional positions of foreign exchange derivatives. That is, we know exactly if firms are long or short in foreign exchange rate. We, then, are able to compare the net position of the firms in foreign exchange derivatives with their foreign exchange exposures to discriminate between those that speculate from those that hedge with these derivatives.

Another contribution of our paper, that we also consider significant, is our emphasis on the study the determinant factors of hedging and speculation of private firms. This paper is one the few in the literature that does an in-depth empirical analysis of the risk strategies using foreign exchange derivatives of these firms in the literature.[9,10]

As Zingales (2000) points out, the bias of the empirical literature toward large firms has led to an excessive concentration of studies on large publicly traded companies, which are certainly the most important ones from a value-weighted point of view, but that are also the ones where internal funds are generally very abundant, external financing is not so relevant and the use of foreign exchange derivatives are modest relative to their size (see Guay and Kotari (2003)). [11]

However, there is a recent growing theoretical and empirical interest in the literature, to study private firms, but this literature still lags due to the lack of good data of these firms. Hence,

[8] See Tirole (2006) for a discussion of the asymmetry information problems of annual reports of firms.
[9] Our paper extends Oliveira and Novaes (2007) study by using a much more detailed database of foreign exchange derivatives, focusing on private firms and by examining a larger sample period.
[10] See Shiozer and Saito (2006) for a paper that looks at the determinants of foreign exchange risk for Brazilian firms using off-balance sheet information.
[11] The average of total assets of firms in our sample is around 15% of the average total assets of a sample of 182 listed firms, whose stocks were more liquid in our sample period.

we think our paper also contributes to this empirical literature by exploiting a new and important database of private firms in Brazil.

We think that our contributions make it possible to get a much richer understanding of managing practices of foreign exchange rate risk of Brazilian private firms. Differently from Bartram (2019), we find that speculation with foreign exchange derivatives in Brazil is truly relevant.

Our results have especially important implications in terms of public policy. They are important for Brazilian policy makers and regulators alike, because of the need to avoid the occurrence or exacerbation of future financial crises, due not only to foreign exchange derivatives speculative motives, but also to the fact that many firms with external debt do not hedge their risk appropriately with foreign exchange derivatives.

The rest of the paper is the following. Section 2 describes the main theories that explain the determinant factors of foreign exchange hedging and speculation. Section 3 describes the data. Section 4 presents the empirical analyses. Section 5 concludes.

2. Determinant Factors of Foreign Exchange Hedging and Speculation[12]

Traditional explanations of why firms manage marketable risks have typically relied on the most cited violations of the Modigliani and Miller (1958) assumptions. In what follows, we will present the main theories that exploit these violations for foreign exchange risk, centering on private firms.[13]

2.1 Costs of Bankruptcy

When a firm's cash flow is not sufficient to meet its payments, it is said to be in financial distress. Costs of financial distress can be direct costs, like costs of bankruptcy proceedings, reorganization costs or fees to attorneys and courts, or indirect costs like clientele loss, bad reputation or, alternatively, discontinuance, of operations. Even before a bankruptcy, financial distress can have negative impact on a firm´s value.

[12] Our discussion in this section follows closely Oliveira and Novaes (2007).
[13] Following Tirole (2006), we do not differentiate between the theoretical explanations for derivatives demand between listed and private firms. However, for some of the existing hypotheses of the determinant of hedging and speculation, we do not have available proxys in the data for private firns. One example is the theory that emphasizes the aversion of executives or shareholders to risk (see Stulz (1984) and Smith and Stulz (1985)). We do not have the data on the total participation of the managers on the profits of the firms that is used in the empirical literature as a proxy for these motives.

By reducing cash flow volatility, the risk management can mitigate the illiquidity problem, thus lowering the expected costs of financial distress (see Smith and Stulz(1985)).The choice to hedge occurs more frequently among firms with greater costs of bankruptcy or greater probabilities of bankruptcy.

Foreign exchange exposures, which result in mismatches between currencies of assets and currencies of liabilities, increase the firms' currency exposure and can imply that currency depreciations increase the probability of bankruptcy. Export revenues and import expenses increase the currency exposure of firms and thus can increase the probability of bankruptcy in the case of a currency appreciation or depreciation, respectively. In our database, as we will explain below, we have proxies for total exports and imports of firms.

Our proxy for foreign exchange exposure is, the value in US dollars of the sum of external debt with total value of imports minus total value of exports divided by total assets, forex_exposure_assets.

In some circumstances, firms that do not belong to a tradable sector can over-hedge their external debt, by acquiring a long notional position in foreign exchange derivative higher than their external debt. This is a situation in which the firm can be both hedging and speculating at the same time.

Finally, businesses with high liquidity will have less incentive to hedge and greater incentive to speculate because, in this case, they have a lesser probability of bankruptcy. As a proxy for this determinant factor, we will use cash divided by total assets, cash_assets.

2.2 Costs of Agency with Creditors

Myers (1977) shows that indebted businesses have distorted incentives in terms of their policies for investment. The distortion occurs due to the priority that the creditors have over the shareholders for receiving cash flow generated by firms. Given this priority, the shareholders do not have incentives to contribute resources for investments whose returns —because of the highly indebted situation—will be used in the payment of debt. Excessive debt, however, can impede lucrative projects from being implemented. Thus, creditors anticipate the conflict of interest and incorporate their costs in the interest rate.

Mayers and Smith (1982) show that a hedge reduces the probability of a company not fulfilling its obligations, thus reducing the probability that the investments are distorted and, consequently, benefiting the shareholders through the reduction of the interest rate. Hedging, therefore, takes a firm's investment policy closer to that which maximizes the firm's value.

On the other hand, Jensen and Meckling (1976) argue that business with great amounts of debt can choose excessively risky investments. This can occur if shareholders speculate to increase the volatility of the firm's cash flow when close to bankruptcy.

We have, therefore, two conflicting forecasts. On one hand, Mayers and Smith (1982) argue that firms highly in debt are more likely to hedge. On other hand, Jensen and Meckling (1976) argue that firms with significant debt have greater incentive to speculate. To determine which of these effects prevail, we use the ratio between the total value of fixed assets and total assets, fixed_assets, for the collateral capacity of a private firm and the ratio between its operational revenue and total assets, oper_rev_assets, as a proxy for its growth opportunities.

Another characteristic of a firm related to its cost of agency with creditors is its size. Larger firms, in general, have greater reputation, a fact that can reduce costs of agency. Therefore, we can expect that the size, defined as natural logarithm of total assets, lassets, to reduce the probability of the firm using hedge or speculation.

We also consider other explanatory variables that are related to firm's profitability. The idea is that the capacity a firm has to finance itself with its own resources, avoiding the capital market or bank loans, decreases its desire to hedge. In this case, the company can run greater risks, for example, by speculating. On the contrary, more profitable firms can also be subject to greater costs related to investment policies because they have more available projects from which to choose, a fact that suggests a greater demand to hedge. This being the case, the impacts of profitability over the probabilities to hedge or speculate are uncertain. We use as proxies for profitability the ratio between Ebitda and total assets, ebitda_assets, and the ratio between operational revenues and total assets, resoper_assets.

2.3 Asymmetric Information

De Marzo and Duffie (1991) suggest that firms with greater asymmetry of information can obtain larger profits by hedging. Hedging reduces the volatility of the companies' cash flow that, in turn, reduces the uncertainties of the shareholders' set of information. Consequently, the shareholders accept a hedge because this improves their portfolio choices. As an empirical

approximation for asymmetric information, we use a dummy variable BNDES equal to 1 if the firm acquired financing with "Banco Nacional de Desenvolvimento Econômico e Social" (hereafter BNDES) in a certain year and 0 otherwise.

BNDES finances both listed and private firms in Brazil. The importance of BNDES for the credit market in Brazil is related to credit constraints for long-term projects in Brazil, which are considered among the most important market failures in the Brazilian economy, as they hamper the entrepreneurial efforts of domestic firms. That is why the Brazilian government provides long-term loans through BNDES a development bank whose main statutory goal is to improve Brazilian economic competitiveness without neglecting broader social aspects.

BNDES invests in several areas including research and development, infrastructure, export support, regional and urban development. More specifically, in the case of manufacturing, BNDES finances long-term projects aimed at the creation of new plants, the enlargement of existing ones, the restructuring and the modernization of production processes, innovation and technological development, export promotion. Overall, the importance of BNDES in the Brazilian economy is quite sizeable.

To receive any loans from BNDES, firms need to send a supporting application form with information of their projects as well as balance sheet information to a retailing bank or to BNDES itself. BNDES or the retailing banks evaluate whether their projects are in line with the purpose of the loans mentioned and if the firm is creditworthiness. After having their application approved, firms must send a complete and detailed project plan to be evaluated. This project plan is analyzed by investigating whether it is economically feasible, what collateral can be used to guarantee the loan and so on and so forth. Therefore, in the process of acquiring a loan at BNDES, asymmetric information between the firm, and the market (shareholders included) is mitigated.

2.5 Taxes

Smith and Stultz (1985) find that a firm benefits on reducing pre-tax income due to a convexity function of the tax codes in the different countries, meaning that effective tax increases with additional pre-tax income. Mian (1996) presents evidence that the awaited payment of taxes is a convex function of the generation of a firm's cash.In this case, the Jensen's inequality shows that a hedge can reduce the expected payment of taxes. By practicing risk management strategies, firms can obtain the optimal level of tax.

Graham and Rogers (2002) discuss the impact of taxes on incentives for firms to hedge, based on the level of their debt. In countries, in which financial expenses imply a fiscal benefit, hedging increases value by increasing a firm's capacity for debt. This, consequently, allows for a lower tax payment.

In order to test for the impact of taxes on the decisions to hedge, we use the ratio of total taxes to total assets, taxes_assets. We expect that firms that pay higher taxes are more likely to hedge and less likely to speculate.

2.5 Economies of Scale

Mian (1996) argues that risk management programs by means of derivatives can present initiation, implementation, and maintenance costs. If these costs are significant, a company may not use these programs. Such costs present economies of scale related to the size of the firm.

However, there are competing arguments for either a positive or a negative relation between firm size and hedging activity. The negative relationship between firm size and direct bankruptcy costs suggests that small firms have a greater incentive to hedge. Small firms are also faced with greater information asymmetries and higher financing transaction costs, which are likely to make external financing more expensive for smaller firms and therefore hedging more likely. Conversely, hedging activity exhibits significant information and transaction cost scale economies implying that larger firms are more likely to hedge.

Therefore, the size of the firm, measured by the natural logarithm of assets, lassets, may or may not be positively related to the probability of hedging or to the probability of speculation.

2.6 Privileged Information in the Foreign Currency Market

Firms with external debt and revenues from exports or expenses from imports are natural candidates to speculate with foreign exchange derivatives. The nature of their activities, makes these firms follow regularly the foreign exchange market, maintaining close contact with economic agents that are probably the first to detect changes in the trends of the nominal exchange rate (*dealers* of foreign currency, for example). Thus, they can participate in the foreign exchange market using privileged information. Our regressor forex_exposure_assets, that we defined above, gives an idea of how this information can affect speculation. On a priori basis, we think that firms that have positive foreign exchange exposure are more likely

to hedge, while firms with negative foreign exchange exposure (total exports higher than the sum of external debt and total imports) are more likely to speculate.

Additionally, we use in our regressions explanatory variables that indicate or not the participation of firms in different sectors, tradable or not. To verify if this participation is important to explain a business' decision to hedge or speculate with foreign exchange derivatives, we include binary variables equal to one when the firm is part of one of these sectors and zero otherwise.

Table 1 summarizes our discussion above, by showing the definitions of the variables that we use in our regressions and the expected signs of the coefficients of these variables.

[Insert Table 1]

3. Data

We have several sources of data of nonfinancial private firms (hereafter firms). The balance sheet information comes from "Valorpro". The information on total value of exports and imports come from currency contracts registered at BCB. Data on financing with BNDES in our sample period comes from BNDES homepage. [14] Finally, the information on the foreign exchange derivative contracts comes from BCB.

3.1 Balance Sheet Information, Foreign Exposure and BNDES Financing

We consider two groups of private firms. One is comprised by those that have outstanding contracts of foreign exchange derivatives in at least the end of one of the years from 2010 to 2021. The other is formed by firms that do not have such contracts open at the end of any of these years. Combining these groups, we have 8,071 firms. We classify them in the following sectors in accordance with "Valorpro" classification: Agriculture, Commerce Energy, Industry and Services.[15]

In the case of the information on exports and imports, we have data on currency contracts written between financial institutions and firms in our sample. In these contracts, there is information if the firms are exporting or importing and the currency used in the foreign exchange transaction. The vast majority of these contracts use US dollars as currency.

[14] www.bndes.gov.br
[15] We do not have multinational firms in our database. These firms have many different ways of managing foreign exchange risks besides demanding foreign exchange derivatives. See for a discussion Crabb (2002).

In the case of BNDES, we verify if firm acquired financing from BNDES in a certain year of our sample period. We looked both at direct and indirect financing.[16]

Table 2 shows descriptive statistics of firms. Table 2 Panel A shows the number of firms for each sector of the economy. There are 5,503 joint stock firms and 2,568 limited liability firms. The sector with more firms is the services sector with 4,111 firms. Table 2 Panel B shows some descriptive statistic of financial characteristics of private firms. Private firms from the energy sector are the bigger ones in terms of assets, while firms from services sector are more profitable on average.

Table 2 Panel C presents the number of firms with foreign exchange exposure measures and BNDES financing. The number of firms with external debt is 1,088 (7.16%) and the industry sector is the one with more private firms having external debt, 360. In terms of the average of the natural logarithm of external debt, energy sector is the one with the highest value, 6.48 million of US dollars. There are 554 (77%) net exporters and 2,227(50%) net importers. Firms from the services sectors are the ones that export and import more. Finally, firms from services sector are also ones with more financing from BNDES, 457(2%).

[Insert Table 2]

3.2 Foreign Exchange Derivative Contracts

Since 2010, BCB collects daily data on contracts of foreign exchange derivatives. This information allows us to find notional amounts of the contracts that are open at the end of the years from 2010 to 2021. In these contracts, firms are long or short in foreign exchange rate.

Our database of foreign exchange derivatives contracts is original and unique. We have 11,081 contracts of swaps of foreign exchange, 160,234 contracts of forwards of foreign exchange, 15,423 contracts of future of foreign exchange and 25,008 contracts of options of foreign exchange, open at the end of each year from 2010 to 2021.

To understand the importance of our database, we need to briefly explain the structure of the Brazilian foreign exchange derivatives market. Currency swap contracts and forward contracts are registered at CETIP. The counterparts are, most often, financial institutions and

[16] See ww.bndes.gov.br for explanations of the difference between direct and indirect financing.

firms. The most common forward or swap contracts are those in which the firm is in the long position of dollar and in the short position nominal interest rate; this implies gains (losses) with depreciation (appreciation) of the exchange rate. The main contracts of firms registered at B3 are future contracts and dollar options. According to available data at B3, dollar-denominated future contracts are only liquid for maturities within 90 days and their open total daily stock is less than total open stock of currency swaps between firms and financial institutions registered at CETIP. Dollar options present daily stock levels even lower than those of dollar-denominated future contracts do. To make nonlinear contracts, such as options, comparable to linear contracts such as forwards, futures or swaps we adjusted them by calculating the delta for each individual option and adding them together. To do so, we use information of December 2019.

Table 3 describes the foreign exchange derivatives contracts in our database. Table 3 Panel A shows the number of contracts classified by type of derivative. Forward contracts are predominant for private firms, followed by options contracts. Most private firms are long in the foreign exchange rate in all foreign exchange derivatives. Table 3 Panel B shows the average and notional values of foreign exchange derivatives contract. The highest average comes from long positions in options contracts. Table 3 Panel C shows the number of contracts of each foreign exchange derivatives for different sectors of the economy. The highest number comes from commerce sector with forward contracts. Finally, Table 3 Panel D shows the average notional of foreign exchange derivative contracts classified by sectors of the economy. The highest average arises from the agricultural sector with forward contracts.

[Insert Table 3]

Next, we define what we consider as hedge and speculation with foreign exchange derivatives.

3.5 Definition of Hedging and Speculation

As we mentioned in the Introduction above, the definition of hedge and speculation with foreign exchange derivatives for a particular firm is a difficult endeavor without knowing ex-ante the risk strategy of this firm in the foreign exchange market.

We are going to define hedge and speculation based on the comparison of the net notional value of foreign exchange derivatives of the firm open at each year from 2010 to 2021 and its foreign exchange exposure. The foreign exposure of a firm, as we explained before, is defined as the value in US dollars of the sum of external debt with total imports minus total exports.

Our definitions of hedge and speculation are related to the transaction costs that private firms face.

Table 4 Panel A shows our definitions of hedging and speculation. In our definitions, we consider net derivatives to be equal to the difference between long and short positions in US dollars.

We have two cases in which we consider a firm to be hedging. They are: foreign exchange exposure positive (forex_exposure>0) and net derivatives positive (net_derivatives>0) (Hedge1); foreign exchange exposure negative (forex_exposure<0) and net derivatives negative (net_derivatives<0) (Hedge2); We define that a firm is doing Hedge (Hedge equal to one) in a certain year if at least one of the definitions of Hedge (Hedge1 or Hedge2) holds for a firm at the end of a certain year of our sample period and zero otherwise.

We have four circumstances in which we consider a firm to be speculating. They are: no foreign exchange exposure (forex_exposure=0) and net derivatives different from zero (net_derivatives#0) (Spec1); foreign exchange is positive (forex_exposure>0) and net derivatives higher than foreign and net derivatives>0 (Spec2); foreign exchange exposure is positive (forex_exposure>0) and net derivatives is lower than zero (net_derivatives<0) (Spec3); foreign exchange exposure is negative (forex_exposure<0) and net derivatives is higher than zero (net_derivatives>0) (Spec4). A firm is speculating, Spec equal to one, if one of the definitions of speculation above holds for a firm at the end of a certain year of our sample period, it is not speculating in none of the definitions of speculation hold.

Our definitions above allow for the possibility that a firm is both hedging and speculating at the same time with foreign exchange derivatives. One example of this would be a firm with foreign exchange debt and non-tradable, in which the notional amount of its long position in foreign exchange derivatives is higher than the value of its foreign exchange debt. In this case, our definitions above would indicate a firm hedging (hedge1) and speculating (spec4) at the same time.

We also are aware that even firms that have no foreign exchange exposure such as external debts, export revenues or import expenses may be indirectly affected by movements of the exchange rate. Therefore, we may be incurring in measurement errors with our definition of speculation in the case of these firms (definition spec1 above). However, following Hagelin (2003) and Bodnar et al. (1996)) we consider that, in this case, hedging is more likely to be

done by operational hedges rather than financial ones, like foreign exchange derivatives. Anyway, we will manage this possible measurement problem in our econometric analyses that we will present later on in the text.

Table 4 Panels B shows that the preferred form of hedging (100.00%) was implemented by firms with positive foreign exchange exposure (hedge1), while speculation was mostly done (85.58%) by firms with no foreign exchange exposure (spec1). Table 4 Panel C shows that the total number of firms that speculated (1,213) is much higher than those that hedged (206). Table 4 Panel D shows that 203 firms that hedged and 215 firms that speculated had external debt.

In summary, the overall picture that we present in Table 4 is that speculation is much more common than hedging in Brazil, in the case of private firms. In the case of hedging, external debt plays a leading role, but in the case of speculation, the impressive evidence is that it is done mostly by firms with no foreign exchange exposure.

[Insert Table 4]

4. Empirical Analyses

4.1 Main Empirical Analyses

We start by presenting mean tests of the financial characteristics of private firms for groups of firms that hedged or not, and for groups of firms that speculated or not. Table 5 shows the results of these tests.

Table 5 indicates that firms that hedged had more foreign exchange exposure than those firms that did not hedge. In the case of speculation, firms that speculated are less profitable than those that did not. Thus, Table 5 presents first empirical evidence that incentives for hedging are related to external debt and imports, while financial gains motivate firms less profitable in their core businesses to speculate.

[Insert Table 5]

We now move on to parametric analyses of the determinant factors that affect the demand of foreign exchange derivatives by private firms. We estimate equation (1) below using Pool of Cross Section. The regressors are the determinant factors of hedge and speculation that we discuss in Section 2 above.

$Prob(hedge_{it}=1 \text{ or } spec_{it}=1|X_{it})=G(X_{it}\beta)$, i=1, N and t=2010, 2021, G()Normal Distribution (1)

We have three different specifications. Our first specification is simple one, controlling only for foreign exchange exposure divided by total assets, forex_exposure_assets. Our second specification includes in the first one control variables that are proxies of the determinant factors of hedge and speculation. In our third and more complete specification, we include in the second specification dummies that indicate sectors of the economy. In all three specifications, we control also for binary variables indicating years of our sample period.

The results of these estimations are shown in Table 6. They, in the case of hedging, clearly show the relevance of the ratio between foreign exchange exposure and total assets. The coefficient of this regressor is positive and statistically significant in all estimations.

In the case of speculation, the main negative determinants are ebitda_asssets and resoper_assets, which are respectively firm´s measures of profitability (both of them) and of growth oportunities (the latter one). The coefficients of these regressors are negative and statistically significant in all estimations. Thus, the results, in our view, seem to point to speculation being driven by firms less profitable in their businesses and that do not have good growth opportunities.

The results shown in Table 6 are not only statistically significant but also economically significant. An increase in 1% forex_exposure_assets, increases the probability of hedging from a minimum of 0.48% to a maximum of 0.52%. Moreover, a 1% increase in Ebitda_assets reduce probability of speculation from a minimum of 23.43% to a maximum of 34.34%, while a 1% increase in ratio between resoper_assets decreases the probability of speculation from 0.017% to 0.018%. [17]

The signs of the coefficients of other control variables are in general expected ones, although most of them are not statistically significant.

[Insert Table 6]

In the next paragraphs, we will verify the robustness of our results presented in Table 6.

[17] Marginal or incremental effects in logit or extreme value models are nonlinear as it is well known. Therefore, we calculate these effects at the sample average of each of the regressors mentioned in this paragraph.

4.2 Robustness Analyses

4.2.2 Pandemic

In a first attempt to evaluate the robustness of our results shown in Table 6, we estimate equation (1) above for hedge and speculation before the Covid-19 pandemic, from 2010 to 2019, and in the Covid-19 pandemic period from 2020 to 2021. Table 7 Panel A presents the results before the pandemic that, once more, show the relevance of the ratio between forex_exposure_assets for hedging and ebitda_assets as well as resoper_assets for speculation**.** However, Table 7 Panel B shows the results during the pandemic period, and they indicate that while forex_exposure_assets continues to affect positively hedging, coefficients Ebitda_assets and resoper_assets are no longer statistically significant.

[Insert Table 7]

4.2.2 Endogeneity

A major concern that we have in our main empirical analyses presented above is the possibility of the existence of endogeneity, due to reverse causality or omitted variables. In the case of the latter, this may occur because we do not have information on variables for firms that proxy issues related to risk aversion of managers. However, we ponder that this motive is more important for listed firms with more dispersed ownership, than for private firms, which, by their nature, have more concentrated ownership.

In the case of reverse causality, some independent variables, which measure potential incentives to hedge and speculation with foreign exchange derivatives, can also be choice variables. In particular, the choice of a firm to issue external debt is the one that causes the greatest concern, because it can be a joint decision with the decision to hedge or speculate. Moreover, we think that exports and imports are less likely to be dependent on the decisions of hedge and speculation because they are inherent to the business of firms.

However, as we show in Table 4 Panel C, not many firms in our database that hedged or speculated had external debt. So, this is evidence, albeit imprecise, that the ratio between foreign exchange exposure and assets may not be endogenous. In addition, Hausman (1978) specification tests do not point to endogeneity of this variable. Despite this evidence of no

endogeneity of the ratio between foreign exchange exposure and total assets, we decide to continue to address this prospect, because there are still theoretical reasons that can justify it. To deal with this possibility, we implement several robustness exercises.

In a first attempt to cope with the possibility of endogeneity, we estimate neighboring matching (NN) and propensity score matching (PSM) with hedge and speculation as outcome dependent variable.

In the case of NN, we consider as outcome independent all the regressors of the more complete main empirical analyses, equations (3) of hedge and speculation of Table 6, with the existence of foreign exchange exposure as a treatment variable and natural logarithm of assets as matching variable.

In the case of PSM, we consider as treatment dependent the existence of foreign exchange exposure and as treatment independent natural logarithm of assets. We also consider only one matching per observation for both NN and PSM.

In a second attempt to deal with endogeneity, we estimate difference-in differences regressions, considering two exogenous shocks: tapering episode of 2013 and Covid-19 pandemic of 2020. In both cases, we interact a dummy for the years 2013 and 2020 respectively with forex_exposure_assets, ebitda_assets and resoper_assets and estimate the models using only years 2013 and 2014 in the case tapering and 2019 to 2021 in the case of Covid-19 pandemic.

Table 8 Panels A and B show the results of our estimations mentioned above to oversee the possibility of endogeneity. The results shown in these Panels are, in general terms, like ones we observe in our main empirical analyses. Once more, we see the relevance of foreign exchange exposure as determinant factor for hedging, while speculation is negatively affected by profitability and growth opportunities.

[Insert Table 8]

4.2.3 Measurement Errors of Hedge and Speculation Variables

Another reasonable and relevant concern of our main results presented in Table 6 is related to our definitions of hedge and speculation. Our criteria can be questioned in several manners. It can be wrong, or it may not describe all the possibilities in which firms could be hedging or speculating.

As we stress earlier in the text, firms may not only consider direct foreign exchange exposure but also indirect foreign exchange exposures. For example, our criteria for speculation look only at the direct foreign exchange exposure. Nevertheless, it may be the case, that some firms that we define as speculating with no observable direct foreign exchange exposure are not doing this (spec1 definition Table 4 Panel A).

To manage possible measurement errors in the dependent binary variables, hedge and speculation, we perform three econometric exercises. In the first one, we follow Haussman et al. (1998). The authors show that misclassification of dependent variables in probit or logit models imply inconsistent coefficient estimates. They propose parametric and semi parametric techniques to correct measurement errors in the binary dependent variables.

In the case of parametric models, they recommend estimating by nonlinear least squares equation (2) below:

$$E[Y|X]=\beta_0+(1-\beta_0-\beta_1)F(X\beta) \quad (2)$$

where Y is the binary dependent variable (in our case hedge or speculation), X is a matrix of regressors, F() is the normal distribution, β_0 is the conditional probability of a zero dependent variable being classified as a one, and β_1 is the conditional probability of a dependent variable equal to one being classified as a zero. In the case, β_0 and β_1 are zero, there is indication of no measurement errors. Haussmant et al. (1998) assume that for identification a monotonicity condition must hold, that is $\beta_0 + \beta_1 <1$.

We estimate equation (2) for hedge and speculation. We use only the regressors, whose coefficients are statistically significant in our main empirical analyses (see Table 6). We estimate two thousand draws of equation (1) for hedge and speculation, using the uniform distribution to provide initial values of the coefficients. [18]

[18] We implement 50 draws, so mitigate the fact that the estimations can be converging to local minimums, instead of global minimums. We also use bootstrap in all estimations to generate robust standard errors.

Table 9 Panel A presents the average of the coefficients β_0 and β_1 estimated as well as the average of their standard deviation. One can observe that they are on average not statistically significant. This, in our view, is a first indication that measurement errors in binary dependent variables, hedge and speculation, may not be truly relevant in our econometric exercises.

In a second robustness exercise concerning possible measurement errors in our definitions of the binary variables hedge and speculation we implement Ichimura (1993) semi-parametric estimation with only the regressors whose coefficients are significant in our main empirical analyses presented in our main empirical analysis for hedge and speculation respectively.[19] From the models that we estimate, we predict the values of hedge and speculation.[20] Table 9 Panel B shows the average and standard deviation of the differences between the observed and predicted values of hedge and speculation. As one can see, the averages are not statistically significant, which we understand as another indication that measurement errors in our dependent variables may not be important.

In a third attempt to assess for measurement errors, we define speculation (spec) excluding the possibility that firms are speculating without observable foreign exchange exposure (spec1). We then estimate the same specifications regarding speculation of our main empirical analyses using a panel logit with random effects. We show the results of this estimation in Table 9 Panel C. As one can verify, they are like the ones we obtain in our main empirical analyses.

[Insert Table 9]

4.2.4 Other Robustness Exercises

We do other robustness exercises. We estimate similar regressions as the one we estimate in our main empirical analyses, including macroeconomic variables as regressors. The macroeconomic variables that we include are the annual growth of seasonally adjusted GDP, average annual SELIC rate, and the annual average foreign exchange rate. The results of these estimations are show in Table 10 and once again are in accordance with the results of our main empirical analyses presented in Table 6.

[19] See Hausman et al. (1998) for a discussion of semi-parametric models to identify possible measurement errors in the binary dependent variable.

[Insert Table 10]

In a final robustness exercise, we use net derivatives of each firm as our dependent variable (the difference between long and short positions in foreign exchange rate). We estimate a panel Logit with random effects model with this dependent variable with the same regressors of our main empirical analyses. Table 11 presents the results and one can verify that foreign exchange exposure is positively related to net derivatives, while the coefficient of ebitda_assets and resoper_assets are positive and not statistically significant.

[Insert Table 11]

5. Conclusion

While surveys and annual reports indicate that many firms use foreign exchange derivatives to take positions depending on their market view, most of the academic risk management literature assumes a hedging motive for firm derivatives use, as Nance et al. (1993) points out.

Our paper fills a gap in the literature of how nonfinancial private firms manage their foreign exchange exposures. The reason is that we analyze in detail the relation between the use of foreign exchange derivatives looking at various private firms risk measures to assess whether the use of these derivatives by them is indeed consistent with hedging, or whether they use these instruments with speculative motives. In addition, we study the determinant factors of hedging and speculation with these derivatives.

Our empirical analyses are based upon a new database of foreign exchange derivatives contracts provided by the BCB. We identify that the most relevant factor for hedging is foreign exchange exposure, while the more profitable private firms are the less incentive they have to speculate. Our results are robust to different specifications and estimations methods and are not only statistically but also economically significant.

We muse that this paper contributes in a relevant way to literature because by using a unique database of foreign exchange derivative contracts of nonfinancial private firms in Brazil it makes possible to distinguish much better the incentives related to speculation and hedge in the foreign exchange market. For regulators, policy makers, shareholders, and other firm´s

[20] Ichimura (1993) semi-parametric estimator assumes no functional form. Parameters are not identified in location or scale. Only ratios of coefficients are identified. To achieve identification, a normalization

stakeholders alike, it is important to be aware of the risk management practices of these firms and the concomitant effects on their risk and value in the foreign exchange market. In this respect, we think that future research on the subject can certainly benefit from the results reported in this paper.

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assumption is required, that is, the coefficient on the first independent variable is equal to one.

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Table 1 Definition of Variables and Expected Signs of Coefficients of the Determinant Factors of Hedging and Speculation with Foreign Exchange Derivatives

	Hegde	Speculation
Costs of Bankrupcy		
ratio between foreign exposure and total assets, forex_exposure_assets (foreign exposure is total debt in US dolllars plus Total Imports Minus Total Exports)	+	-
cash_assets	-	+
Costs of Agency with Creditors		
ratio between fixed assets and total assets, fixed_assets	-	+
natural logarithm of total assets, lassets	-	+
ratio between Ebitda and total assets, Ebitda_assets	-	+
ratio between operational revenues and total assets, resoper_assets	-	+
Assymetric Information		
BNDES	-	-
Economies of Scale		
Natural Logarithm of total assets, lassets	+	+
Taxes		
Ratio between total Taxes and total Assets, taxes_assets	+	-
Privileged Information in the Foreign Exchange Market		
ratio between foreign exposure and total assets, forex_exposure_assets	+	+

Table 2 Descriptive Analysis of the Firms

The information comes from "Valorpro". The sectors of the economy are those that "Valorpro" uses. Panel A shows the number of firms in our database separated in sectors of the economy and in joint stock or limited liability. Panel B shows means and standard deviation (second number) of financial and balance sheet characteristics of firms that we use in our empirical analysis. Panel C shows, classified in sectors of the economy, the number of firms with external debt, the average ratio between total external debt and total assets, the number of exporters, the number of importers and the number of firms that obtained financing with BNDES in our sample period.

Panel A Sectors, Number and Types of Firms

Sectors	Joint Stock	Limited Liability	Total
Agriculture	179	16	195
Commerce	573	217	790
Energy	778	218	996
Industry	1,358	621	1,979
Services	2,615	1,496	4,111
Total	5,503	2,568	8,071

Panel B Mean of Financial Characteristics Private Firms

	Agriculture	Commerce	Energy	Industry	Services
lassets	12.1294	12.0942	12.1532	12.0026	12.1001
	1.8791	1.8501	1.9772	1.8554	1.8684
cash_assets	0.0739	0.0857	0.0899	0.0863	0.0896
	0.0883	0.1262	0.1291	0.1319	0.1328
ebitda_assets	0.0098	0.0109	0.1645	0.0066	0.0255
	0.0962	0.3393	5.2173	0.1206	0.8010
fixed_assets	0.2698	0.2579	0.2577	0.2651	0.2622
	0.2375	0.2643	0.2471	0.2515	0.2508
current_liquidity	30.6197	3.7129	44.7306	2.8903	310.3171
	342.3818	26.3658	1907.9517	9.0430	16990.2016
operational_results_assets	0.0273	-0.0378	0.0718	0.0658	1.5506
	0.3410	17.6941	1.9746	0.7986	115.4686
ROE	-32.5847	NA	20.0130	-23.4207	2489.2413
	1021.4716	NA	598.8167	1303.4536	122514.0589
Taxes_assets	0.0122	0.2713	0.0211	0.0256	0.0212
	0.0251	9.3324	0.0532	0.2268	0.0413

Panel C Foreign Exchange Exposure of Private Firms and BNDES Financing

	Firms with External Debt	Mean(log(Fin_US_Debt)) Millions of US$	Firms Exporter	Mean(log(Exports)) Millions of US$	Importer	Mean(log(Imports)) Millions of US$	BNDES Financing
Agriculture	5	5.84	6	4.64	26	4.70	6
Commerce	77	6.57	54	4.58	209	4.88	85
Energy	177	6.48	94	4.90	365	4.74	163
Industry	360	6.15	138	4.43	555	4.85	246
Services	469	6.04	262	4.56	1,072	4.69	457
Total	1,088		554	23	2,227	24	957

Table 3 Foreign Exchange Derivative Derivatives Contracts

The derivatives contracts data in this study were obtained from confidential information of Banco Central do Brasil. Some of these contracts are registered at the B3 (previously known as Brazilian Mercantile & Futures Exchange) and others are registered at Custody and Settlement Clearing, CETIP. A firm is in a long (short) position in the foreign exchange derivative contract when it is long (short) in the foreign exchange rate. Panel A shows the number of derivative contracts in the long and short position. Panel B shows the average notional values of foreign exchange derivatives contracts. Panel C shows the number of foreign exchange derivative contracts separated by sectors of the economy. Panel D shows the average notional of foreign exchange derivative contracts classified in sectors of the economy.

Panel A Number of Contracts of Foreign Exchange Derivatives

Forward		Options		Swap		Future	
Long	Short	Long	Short	Long	Short	Long	Short
77,178	83,056	13,142	11,866	8,860	2,221	7,739	7,684

Panel B Mean Notional Values of Foreign Exchange Derivatives Contracts (US Dollars)

Future		Options		Swap		Forward	
Long	Short	Long	Short	Long	Short	Long	Short
4.76E+07	1.10E+08	1.88E+08	2.04E+08	5.87E+07	1.54E+08	1.31E+07	1.26E+07

Panel C Number of Contracts of Foreign Exchange Derivatives Separated by Sectors of the Economy

	Forward		Options		Swap		Future	
	Long	Short	Long	Short	Long	Short	Long	Short
Agriculture	5,165	6,857	86	102	241	92	0	0
Commerce	41,106	43,632	773	609	2,941	426	7,739	7,684
Energy	6,863	9,732	512	523	1,550	300	0	0
Industry	19,320	21,013	11,598	10,534	2,599	1,276	0	0
Services	4,724	1,822	173	98	1,529	127	0	0
Total	77,178	83,056	13,142	11,866	8,860	2,221	7,739	7,684

Panel D Firms Foreign Exchange Derivatives Notional Net Positions by Sectors of the Economy (US Dollars)

	Future		Option		Swap		Forward	
	Long	Short	Long	Short	Long	Short	Long	Short
Agriculture	115,778,061	193,109,303	17,447,979	10,980,049	19,053,394	12,702,869	0	0
Commerce	23,196,526	134,819,623	19,482,817	24,894,312	37,753,793	44,226,623	13,136,364	12,566,282
Energy	74,500,113	93,083,168	25,336,793	45,218,978	153,802,171	139,940,852	0	0
Industry	63,652,146	91,039,639	339,103,934	363,173,676	45,554,776	261,717,619	0	0
Services	19,669,266	31,583,729	76,025,354	51,207,793	48,828,540	52,738,995	0	0

Table 4 Definition of Hedge and Speculation

Panel A presents the definitions of hedge and speculation with foreign exchange derivatives. Panel B shows the percentage of types of hedging and speculation. Panel C shows the number of firms that hedged or speculated separated by sectors of the economy. Panel D shows the number of firms that hedged and speculated, separated by sectors of the economy, that had external debt, were exporters or importers and had financing with BNDES.

Panel A Definition of Hedge and Speculation

Types of Hedge	
Hedge1	Foreign Exchange Exposure >0 and Net derivatives >0
Hedge2	Foreign Exchange Exposure <0 and Net Derivatives >0
Hedge	Hedge1 or Hedge2
Types of Speculation	
Spec1	Foreign Exchange Exposure=0 NetDerivatives#0
Spec2	Foreign Exchange Exposure>0 and Net Derivatives>Foreign Exchange Exposure
Spec3	Foreign Exchange Exposure<0 and NetDerivatives>0
Spec4	Foreign Exchange Exposure>0 and Net Derivatives<0
Spec	Spec1 or Spec2 or Spec3 or Spec4

Panel B Percentage of Types of Hedge and Speculation

	Hedge		Spec
Hedge1	100.00%	spec1	85.5751%
Hedge2	0.00%	spec2	11.2585%
		spec3	0.5413%
		spec4	2.6252%
		spec5	0.4122%

Panel C Number of Private Firms that Hedged and Speculated Separated by Sectors of the Economy

	Number of Firms that Hedged	Number of Firms that Speculated
Agriculture	3	53
Commerce	51	279
Energy	45	159
Industry	66	508
Services	41	214
Total	206	1213

Panel D Hedge and Speculation of Private Firms: Number of Private Firms with External Debt, Exports, Imports, Financing from BNDES and Average Ratio External Debt to Total Assets

	Hedge			
	External Debt	Exporter	Importer	BNDES
Agriculture	3	1	1	1
Commerce	51	1	4	2
Energy	45	1	6	2
Industry	63	1	1	1
Services	41	1	2	1
Total	203	5	14	7

	Speculation			
	External Debt	Net Exporter	Importer	BNDES
Agriculture	3	1	7	2
Commerce	50	9	48	17
Energy	46	5	9	6
Industry	78	7	36	20
Services	38	5	12	8
Total	215	27	112	53

Table 5 Mean Tests of Balance Sheet and Financial Characteristics of Hedge and Speculation

This Table presents the t statistics of the mean tests of balance sheet and financial characteristics of private firms depending if they hedged or speculated in our sample period. * p<0.10 ** p<0.05 *** p<0.01.

	Hedge(1-0)	Spec(1-0)
forex_exposure_assets	1.6630*	-0.515
bndes	-1.236	-1.636*
cash_assets	-1.652*	-1.249
debt_assets	-1.894*	0.1039
ebitda_assets	-0.482	-1.9124*
fixed_assets	-0.199	-0.730
lassets	-0.533	-0.255
resoper_assets	-0.682	-0.270
taxes_assets	0.7599	-0.356

Table 6 Main Empirical Analyses: Panel Extreme Value and Logit with Random Effects
We estimate using Panel Extreme Value for Hedge and Logit for Speculation with random effects controlling for heteroscedasticity. We estimate three different specifications for hedge and speculation. Our first specification is simple one, controlling only for external debt, export and import. Our second specification includes control variables that are proxies of the determinant factors of hedge and speculation, besides the ones of the first specification. In our third and more complete specification, we include in the second specification dummies of sectors of the economy.

	Hedge			Speculation		
	EQ (1)	EQ (2)	EQ (3)	EQ (1)	EQ (2)	EQ (3)
forex_exposure_assets	0.0052***	0.0048**	0.0048**	0.0000143	-0.004	-0.004
	(5.410146)	(2.405673)	(2.421382)	(0.160085)	(-0.8190)	(-0.78159)
BNDES		0.4669	0.5644*		-0.313	-0.150
		(1.586633)	(1.893879)		(-1.1752)	(-0.52616)
cash_assets		1.1834*	1.5126**		0.0521	0.3757
		(1.445943)	(2.296495)		(0.11163)	(0.759542)
debt_assets		0.1279	0.1824		-0.469	-0.529
		(0.297692)	(0.405423)		(-1.4429)	(-1.48488)
ebitda_assets		-10.40	-4.280		-23.43*	-34.34**
		(-1.03690)	(-0.42987)		(-1.6400)	(-2.04509)
fixed_assets		0.0902	-0.082		0.1336	0.1747
		(0.315199)	(-0.26999)		(0.76678)	(0.910016)
lassets		-0.106	-0.068		-0.015	-0.016
		(-2.55047)	(-1.63437)		(-0.6065)	(-0.58570)
resoper_assets		-0.00015***	-0.00012***		-0.0001721***	-0.0001828***
		(-2.70171)	(-2.22)		(-2.7357)	(-2.68923)
taxes_assets		-12.78**	-11.48*		-0.064	0.1369
		(-2.03)	(-1.76)		(-0.005)	-0.1
Sectors	No	No	Yes	No	No	Yes
Year Dummies	Yes	Yes	Yes	Yes	Yes	Yes
Robust Heteroskedasticity	Yes	Yes	Yes	Yes	Yes	Yes
Marginal Effects forex_exposure_assets	0.000405***	0.000326**	0.00099**			
Marginal Effects ebitda_assets					-5.1598*	-7.0638**
Marginal Effects resoper_assets					-0.000403***	-0.000354***
					(-1.64)	(-2.05)
Observations	14,682	1,439	1,439	14,682	1,439	1,439

t statistics under parenthesis

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

Table 7 Hedge and Speculation Before and After Covid-19 Pandemic

We estimate equation (1) in the text using pool of cross section for hedge and speculation before Covid-19 pandemic, from 2010 to 2019, and in the Covid-19 Pandemic period from 2020 to 2021. Panel A presents the results before the pandemic and Panel B shows the results during the pandemic period.

Panel A Before Covid-19 Pandemic

	Hedge			Speculation		
	EQ (1)	EQ (2)	EQ (3)	EQ (1)	EQ (2)	EQ (3)
forex_exposure_assets	0.0046***	0.0035	0.0035	0.0000158	-0.018***	-0.018
	(3.502082)	(1.568092)	(1.540654)	(0.273631)	(-3.07012)	(-2.69963)
BNDES		0.3107	0.4071		-0.234	-0.082
		(0.936719)	(1.210424)		(-0.84398)	(-0.27539)
cash_assets		0.6619	1.0061		-0.005	0.3110
		(0.957897)	(1.436335)		(-0.01124)	(0.610870)
debt_assets		-0.029	0.0034		-0.409	-0.488
		(-0.05955)	(0.006527)		(-1.21034)	(-1.30577)
ebitda_assets		-6.734	0.2123		-27.57*	-42.16
		(-0.73278)	(0.020222)		(-1.67685)	(-2.19090)
fixed_assets		0.1137	-0.086		0.1564	0.1852
		(0.371542)	(-0.26471)		(0.849081)	(0.910860)
lassets		-0.105	-0.062		-0.031	-0.040
		(-2.39015)	(-1.43162)		(-1.13272)	(-1.37562)
resoper_assets		-0.000	-0.000		-0.0001***	-0.0001**
		(-5.13170)	(-4.69620)		(-4.22367)	(-2.40495)
taxes_assets		-11.19***	-9.772***		0.0728***	0.1927***
		(-233586.)	(-209758.)		(962.2129)	(1414.798)
Sectors	No	No	Yes	No	No	Yes
Year Dummies	Yes	Yes	Yes	Yes	Yes	Yes
Robust Heteroskedasticity	Yes	Yes	Yes	Yes	Yes	Yes
Marginal Effects forex_exposure_assets	0.000345***	0.000244	0.000222			
Marginal Effects ebitda_assets					-0.3544***	-6.0438**
Marginal Effects resoper_assets					-0.0000325***	-0.000238***
Sample Period	2010-2019	2010-2019	2010-2019	2010-2019	2010-2019	2010-2019
Observations	13,128	1,286	1,286	13,128	1,286	1,286

t statistics under parenthesis

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

Panel B During Covid-19 Pandemic

	Hedge			Speculation		
	EQ (1)	EQ (2)	EQ (3)	EQ (1)	EQ (2)	EQ (3)
forex_exposure_assets	0.0057***	0.0111***	0.0123***	0.00001	-0.000	-5.853
	(4.11)	(4.259522)	(3.411006)	(0.14631)	(-0.13769)	(-0.03681)
BNDES		2.1806	2.5723		-4.461	-4.132
		(2.861241)	(2.960273)		(-19.6056)	(-9.51532)
cash_assets		16.265	19.693		0.8873	0.9945
		(5.767205)	(3.942807)		(0.460518)	(0.472360)
debt_assets		5.1088	6.3057		-1.410	-1.239
		(4.040540)	(4.015542)		(-1.61980)	(-1.46418)
ebitda_assets		-27.49	7.9111		-3.5332	-6.4521
		(-0.22871)	(0.323328)		(-0.202943)	(-0.345725)
fixed_assets		-0.189	0.2351		-0.028	0.1886
		(-0.15674)	(0.207790)		(-0.04875)	(0.290989)
lassets		-0.291	-0.357		0.1050	0.1560
		(-1.44037)	(-1.98401)		(1.287699)	(1.823581)
resoper_assets		1.3567	1.2578		0.0761	0.0527
		(1.078101)	(0.827209)		(0.251858)	(0.152925)
taxes_assets		-134.3	-168.4		-5.721	-3.375
		(-106.792)	(-110.764)		(-18.9163)	(-9.79306)
Sectors	No	0	-0.596410875	No	No	Yes
Year Dummies	Yes	0	-0.392235077	Yes	Yes	Yes
Robust Heteroskedasticity	Yes	Yes	Yes	Yes	Yes	Yes
Marginal Effects forex_exposure_assets	0.0005957***	0.000431***	0.0004424***			
Marginal Effects ebitda_assets					0.6259	1.0964
Marginal Effects resoper_assets					0.1349	0.0089
Sample Period	2020-2021	2020-2021	2020-2021	2020-2021	2020-2021	2020-2021
Observations	1,554	153	153	1,554	153	153

t statistics under parenthesis

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

Table 8 Robustness Exercises Considering Endogeneity

In Panel A, we present the results of Treatment Effects Estimations. We estimate neighboring matching (NN) and propensity score matching (PSM) with hedge and speculation as outcome dependent variable. In the case of NN, we consider as outcome independent all the regressors of the more complete main empirical analyses, equations (3) of hedge and speculation of Table 6, with the existence of foreign exchange exposure as a treatment variable and natural logarithm of assets as matching variable. In the case of PSM, we consider as treatment dependent the existence of foreign exchange exposure and as treatment independent natural logarithm of assets. We also consider only one matching per observation for both NN and PSM. In Panel B, we present the results of the estimations of Differences-in-Differences Probit models with fixed effects. We show only the coefficients of the interaction terms between forex_exposure_assets, ebitda_asset, in the case of hedging and speculation respectively, with exogenous shocks (tapering in 2013 and COVID-19 pandemic in 2020).

Panel A Average Treatment Effects (ATE)

	ATE	
	Hedge	Speculation
NN	0.43***	0.2*
	(10.63)	(1.70)
PSE	0.41***	0.38
	(11.25)	(1.37)

Panel B Differences-in-Differences: Tapering and Covid-19 Pandemic

	Hedge	SPEC	
	forex_exposure_assets	Ebitda_assets	resoper_assets
dif-dif tapering	0.00237***	-3.80*	-0.00023*
	(4.21)	(-1.68)	(-1.70)
dif-dif Covid-19 Pandemic	0.001821***	-6.43	-0.00012*
	(3.97)	(-0.86)	(-1.71)

t statistic under parenthesis

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

Table 9 Measurement Errors of Dependent Variables of Binary Models:
Panel A shows the results of the non-linear least squares estimation following Haussman et al. (1998) of the coefficients (standard errors under parentheses) that measure possible errors in the conditional probabilities of hedge and speculation. Panel B shows the difference between observed and predicted hedge and speculation based on semiparametric estimations of Ichimura(1993). Panel C shows the results of the estimations of speculation as dependent variable not considering in its definition the possibility of doing it without observable foreign exchange exposures.

Panel A Error in Dependent Binary Variables: Haussman et al. (1998)

	Error Hedge	Error Speculation
β0	0.01	0.038
	(0.09)	(0.12)
β1	0.044	0.18
	0.05	0.03
OBS	3247	1927

standard deviation under parenthesis
number of observations under brackets
* p<0.10 ** p<0.05 *** p<0.01

Panel B Semiparametric Estimation using Ichimura (1993) **: Difference between observed and predicted hedge and speculation**

Error Hedge	Error Speculation
1.73	-39.10
(32.25)	(594.81)
Obs: 1,224	Obs:251

standard deviation under parenthesis

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

Panel C Excluding Speculation with Foreign Exchange Derivatives without Observable Foreign Exchange Risk

	Speculation		
	EQ (1)	EQ (2)	EQ (3)
forex_exposure_assets	-2.118	1.0403	7.1540
	(-0.2363)	(0.62828)	(051828)
bndes		-1.443	-1.526
		(-1.1942)	(-1.1823)
cash_assets		-0.361	-0.725
		(-0.1586)	(-0.4315)
debt_assets		-0.921	-0.631
		(-0.6880)	(-0.7880)
ebitda_assets		-291.0***	-237.8***
		(-2.7286)	(-2.3186)
fixed_assets		-0.072	-0.043
		(-0.0816)	(-0.0436)
lassets		-0.303**	-0.146***
		(-2.1976)	(-2.8776)
curr_liquidity		-0.400***	-0.477***
		(-3.5927)	(-3.42927)
resoper_assets		-0.2737**	-0.028***
		(-2.45314)	(-2.36314)
roe		0.0013	0.0015
		(0.0124)	(0.0024)
taxes_assets		-0.126	-15.85
		(-1.7200)	(-1.6482)
Sectors	No	No	Yes
Random	Yes	Yes	Yes
Robust Heterocedasticity (cluster sectors)	Yes	No	Yes
Observations	33,835	918	918

t statistics under parenthesis

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

Table 10 Including Macroeconomic Variables

We estimate similar regressions as the one we estimate in our main empirical analyses, including macroeconomic variables as regressors. The macroeconomic variables that we include are the annual growth of seasonally adjusted GDP, average annual Selic rate, and the annual average foreign exchange rate.

	Hedge	Spec
forex_exposure_assets	0.00125***	
	(10.04)	
ebitda_assets		-5.902*
		(-1.720)
resoper_assets		-0.730**
		(-2.61)
Sectors	No	No
Robust Heterocedasticity	Yes	Yes
Observations	918	918

t statistics under parenthesis

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

Table 11 Estimation with the Dependent Variable Net Derivatives

The dependent variable is net derivatives (the difference between long and short positions in foreign exchange rate). We estimate a panel Logit regression with random effects and with the same regressors used in our main empirical analyses.

	Net_Derivatives	
forex_exposure_assets	0.0043**	
	(1.9925)	
ebitda_assets		2.12
		(1.52)
resoper_assets		7.07
		(1.3918)
Sectors	Yes	Yes
Robust Heterocedasticity (cluster sectors)	Yes	Yes
Observations	612	516

t statistics under parenthesis

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