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Debt composition and exchange rate balance sheet effect in Brazil: a firm level analysis

Marco Bonomo*, Betina Martins, Rodrigo Pinto

Graduate School of Economics, Fundação Getulio Vargas, Praia de Botafogo 190/1110, Rio de Janeiro, RJ 22253-900, Brazil

Abstract

In this paper, we study the interaction between macroeconomic environment and firms' balance sheet effects in Brazil during the 1990's. We start by assessing the influence of macroeconomic conditions on firms' debt composition in Brazil. We found that larger firms tend to change debt currency composition more in response to a change in the exchange rate risk. We then proceed to investigate if and how exchange rate balance sheet effects affected the firms' investment decisions. We test directly the exchange rate balance sheet effect on investment, but the results were not statistically significant. We then pursue an alternative investigation strategy, inspired by the credit channel literature. According to this perspective, Tobin's q can provide an adequate control for the competitiveness effect on investment. Our results provide supporting evidence for imperfect capital markets, but not for a balance sheet effect in Brazil. The main effect we found is that firms in industries with higher proportion of imported inputs tend to invest less when the exchange rate is depreciated.

JEL classifications: E22; F31

Keywords: Brazil; Investment; Exchange rate; Balance sheet effects; Credit constraints

1. Introduction

The macroeconomic environment interacts with the firms' balance sheet structure in a two-way relationship. On one hand, macroeconomic environment is central in shaping the capital markets, determining what kind of contracts is feasible and enforceable. Moreover, it also affects the incentives faced by firms when selecting their financial contracts. Conversely, the firms' balance sheet structure affects

*Corresponding author.
E-mail address: bonomo@fgv.br (M. Bonomo).

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crucially the result of macroeconomic policies, influencing policymakers' choices of regimes and policy rules. In this paper, we study the balance sheet effects of exchange rates and interest rates in Brazil since 1990, using a panel data set with firm level variables. For this endeavor, we also consider how the macroeconomic environment affected the balance sheet structure and interacted with firms' balance sheet effects.

Balance sheet effects on investment and production rely on capital market imperfections. According to the credit channel literature (see Bernanke and Gertler, 1995), imperfect information creates a wedge between internal and external finance. An adverse shock to the net worth of a financially constrained firm increases its cost of external financing and decreases the ability or incentive to invest, and to implement production plans. It should impact firms differently, being stronger for firms that face higher premium of external finance costs relative to internal finance (see Hubbard, 1998).

There is substantial empirical evidence that proxies for firms' net worth affect investment more for low net worth than for high net worth firms (Hubbard, 1998). Therefore, to the extent that exchange rate and interest rate variations affect firms' net worth, their balance sheet effect should matter for determining investment. Firms will see their financial condition deteriorate whenever they have substantial debt at floating interest rates, and the relevant real interest rate increases. This can happen if they have foreign denominated debt and the real exchange rate depreciates, entailing an exchange rate balance sheet effect. An interest rate effect takes place when firms have substantial short-term domestic debt or long-term debt contracted at floating rates, since their loans will be rolled over at higher rates.

In the case of interest rates, it engenders a financial accelerator, which magnifies the traditional interest rate channel (Bernanke et al., 1999). In the case of exchange rate, it should counteract the expansionary effect of the competitive channel (Aghion et al., 2001).[1] Thus, while the question in the interest rate literature is about the magnitude of the recessive impact of interest rate rises the debate in the recent exchange rate literature is about whether exchange rate devaluations are expansionary or contractionary.

Harvey and Hoper (1999) argued, in an investigation which used firm level indicators that the exchange rate balance sheet effect greatly exacerbated the Asian Crisis. Bleakley and Cowan (2002) and Forbes (2002) tested the empirical relevance of exchange rate balance sheet effects using multinational panel regressions with firm level data. The former work used a panel data for over 500 non-financial firms in five Latin American countries, dominated by Brazilian firms (52.5% of the observations). They found that holding foreign-currency denominated debt was associated with more investment during exchange rate devaluations, contrary to the predicted sign. However, Forbes (2002) found that more indebted firms had lower net income growth after a large depreciation. Although she used a larger sample of countries, she only examined large depreciations.

[1] Additionally, the existence of imported inputs could also be an extra channel for the exchange rate contractionary effect (Reif, 2001).

One advantage in focusing one specific country is that we can take into consideration the relevant specifics of the macroeconomic environment in this economy. The macroeconomic conditions changed drastically in the last 12 years. First there was an important trade liberalization, which occurred in the early 1990s. Simultaneously, the control of international financial flows was softened, increasing the access of Brazilian firms to foreign liabilities. The Real plan in 1994 ended the high inflation period in Brazil, unveiling the new incentives, and at the same time creating additional ones. The sudden reduction of inflation rate and its volatility contributed for the strengthening of credit relations and for the lengthening of debt maturities. This happened at first in an environment characterized by low volatility of the real exchange rate. In the beginning of 1999, the exchange rate was allowed to float. This change of exchange rate regime was complemented by the adoption of an inflation targeting monetary regime. As a result, exchange rate became very volatile while interest rate policy became focused on bringing inflation to target.

At firm level, investment is the candidate variable potentially more influenced by balance sheet effects. Balance sheet effects might additionally affect production. Since firms cash flow could be an important channel through which balance sheet deterioration affect investment, we also investigate how cash flows affect investment (also measure of capital market imperfection), and how they are influenced by our balance sheet effects.

We start by studying the relation between the macroeconomic environment and the balance sheet structure. After briefly providing some background information about the macroeconomic reforms in Brazil, we proceed by analyzing the determinants of debt composition. Our main finding is that larger firms react more to an increase in exchange rate risk than smaller firms by reducing the proportion of foreign currency debt in their liabilities. We then study the balance sheet effects. We perform several tests, starting with some basic equation where the balance sheet effect of exchange rate is tested directly. We do not find any significant effect of firm's dollar indebtedness on investment when exchange rate is devalued. The only robust effect we found is that firms in industries with higher proportion of imported inputs invest less when the real exchange rate is more depreciated. We also investigate if by allowing exchange rate balance sheet effects to vary over periods we could find different results. Our findings suggest that if exist a negative exchange rate balance sheet effect, it is due to the floating exchange rate period. We then explore the link between balance sheet effects and investment through a common test of capital market imperfection. Our claim is that Tobin's q could provide a better control for the competitiveness effect. Our results provide evidence for imperfect capital markets, but not for the existence of balance sheet effects of exchange rate. We also follow the capital market imperfection tradition by testing if the balance sheet effects are stronger for firms with characteristics that make them more likely to be financial constrained, but the results we found go in the opposite direction: large firms tend to have a negative balance sheet effect.

We proceed as follows. In the next section, we provide the general macroeconomic background for the period of analysis. In Section 3 we describe our database. The

investigation methodology is outlined in Section 4. Section 5 presents the results and the last section concludes.

2. Macroeconomic and institutional environment

The reforms in Brazil changed substantially the macroeconomic environment. This should affect the restrictions and incentives firms face when deciding how to finance their activities, and especially investment. The equity market in Brazil remained in the whole period as a marginal source of funds. Therefore, the sources of funds for investment were either retained profits or debt. Given the high level of interest rates, and the scarcity of long-term loans caused by the macroeconomic instability, the internal source was presumably very important.

Our period of analysis starts in the early 1990s, when tariffs were substantially reduced. The average nominal tariff plunged from 39.6% in 1988 to 11.2% in 1994. Trade liberalization should make firm performance more sensitive to exchange rate, since it should play a more relevant role in determining the competitiveness of domestic tradable products. There was also an important financial liberalization that gave firms more access to foreign assets and liabilities. Among the important advancements in this direction we could cite the successful launch of an important privatization program, the reached agreement to restructure arrears on the external debt, and the approved new rules allowing foreign investment in domestic market and the financing of Brazilian firms in foreign markets (see Table 1). However, macroeconomic instability was still responsible for a reduced supply of foreign and domestic long-term credit.

In 1994, the Real plan succeeded in finishing the chronic inflationary process. Brazil has had one of the world's longest high inflation processes (see Fig. 1b). Long-term debt and financial assets had practically disappeared, and even shorter-term financial instruments had become indexed to the inflation rate or to the daily interest rate. Low inflation coupled with new financial regulation which outlawed indexation provided a completely new environment for financial decisions, resulting in increased debt maturity and reduced indexation.

From July 1994 to 1998, with exception of the initial 8 months where it was led to appreciate (see Fig. 1c), the exchange rate was controlled and stable, as the Central Bank was committed to prevent any abrupt devaluation.[2] The successful stabilization contributed to a substantial increase in the flow of foreign investments. However, the recurrent emerging markets crises would make the flow cyclical. As a response, the government changed cyclically the legislation, reducing the incentives to capital inflows in the good times, and undoing it in the bad times. Few months after the stabilization, the Mexican crisis hit capital inflows to Brazil severely. The situation was reversed in the second semester of 1995. From then on, external debt became a relatively important source of financing for large firms, subject to cyclical interruptions in the new flows caused by the succession of emerging markets crisis.

[2] For a detailed analysis of the exchange rate policy in Brazil during the nineties see Bonomo and Terra (2001)

Table 1
Chronology of important political, financial and economic events in Brazil

Date	Description
1990.03	Collor Plan froze liquid financial assets creating a big liquidity squeeze (from 30% to 8% of GDP). Payments on government debt would be suspended for 18 months. Creation of a commercial market for foreign exchange rates transactions involving goods, complementing the floating market for restricted financial transaction.
1991.01	2nd Collor Plan: heterodox stabilization plan based on price freezing.
1991.05	New and more orthodox economic team. Creation of the so-called Annex IV, which provided a channel for foreign investment in domestic security markets.
1991.07	Rules for borrowing external resources though the ADR/IDR mechanism were adopted.
1991.09	Devaluation of 14%
1991.11	Privatization plan successfully started.
1992.07	An agreement was reached on the reestructuring of interest payments for debt.
1992.09	Impeachment of President Collor, replaced by Vice-President Itamar Franco
1993.05	Fernando Henrique Cardoso was chosen Finance Minister. He and his team would formulate the Real Plan
1993.10	First ADR was issued.
1994.05	A new unit account URV was created to hyper-index the economy, as a preparation for the Real Plan
1994.07	The new currency was created based on the URV, and inflation fell abruptly. De-indexation of contracts. Exchange rate was set an upper limit of 1, but no lower limit and was let to appreciate.
1994.10	Fernando Henrique Cardoso elected president
1994.11	Mexican crisis would affect capital inflows to Brazil.
1995.03	Exchange rate band system was formerly adopted, with a band of 5%. Exchange rate was devalued in 5.2%.
1995.07	Periodic exchange rate spread auction was started, establishing very narrow limits for exchange rate fluctuations.
1995.11	As a response to the banking crisis caused by the dissipation of inflation tax, the government instituted a program known as PROER to facilitate the restructuring of the private banking sector.
1996.02	US$8.2 billion bailout of Banco do Brasil
1996.10	Financial transactions tax of 0.2% approved by the congress.
1997.10	Asian crisis affected capital flows to Brazil.
1998.10	President Fernando Henrique Cardoso was reelected.

1998.07	Russian crisis affected capital flows to Brazil.
1999.01	The Central Bank announced 15% exchange rate devaluation on 01/14 and the creation of new band system. Currency was left to float three days later.
1999.06	The Central Bank adopted an inflation targeting framework for monetary policy.
2000.06	The Congress passed the Fiscal Reponsability Law restricting State and Municipalities ability to generate budget deficits.
2001.03	Government reacted to energy crisis (low level of water stocks) imposing energy rationing. - Contagion from Argentinean crisis.
2002	From May on deterioration of the international perception of Brazilian risk due to the prospect of a leftist government: sharp devaluation of currency and depreciation of Brazilian bonds.

Sources: Bekaert and Harvey (2002) and Bonomo and Terra (2001); Annual report of Banco Central do Brasil, several years.

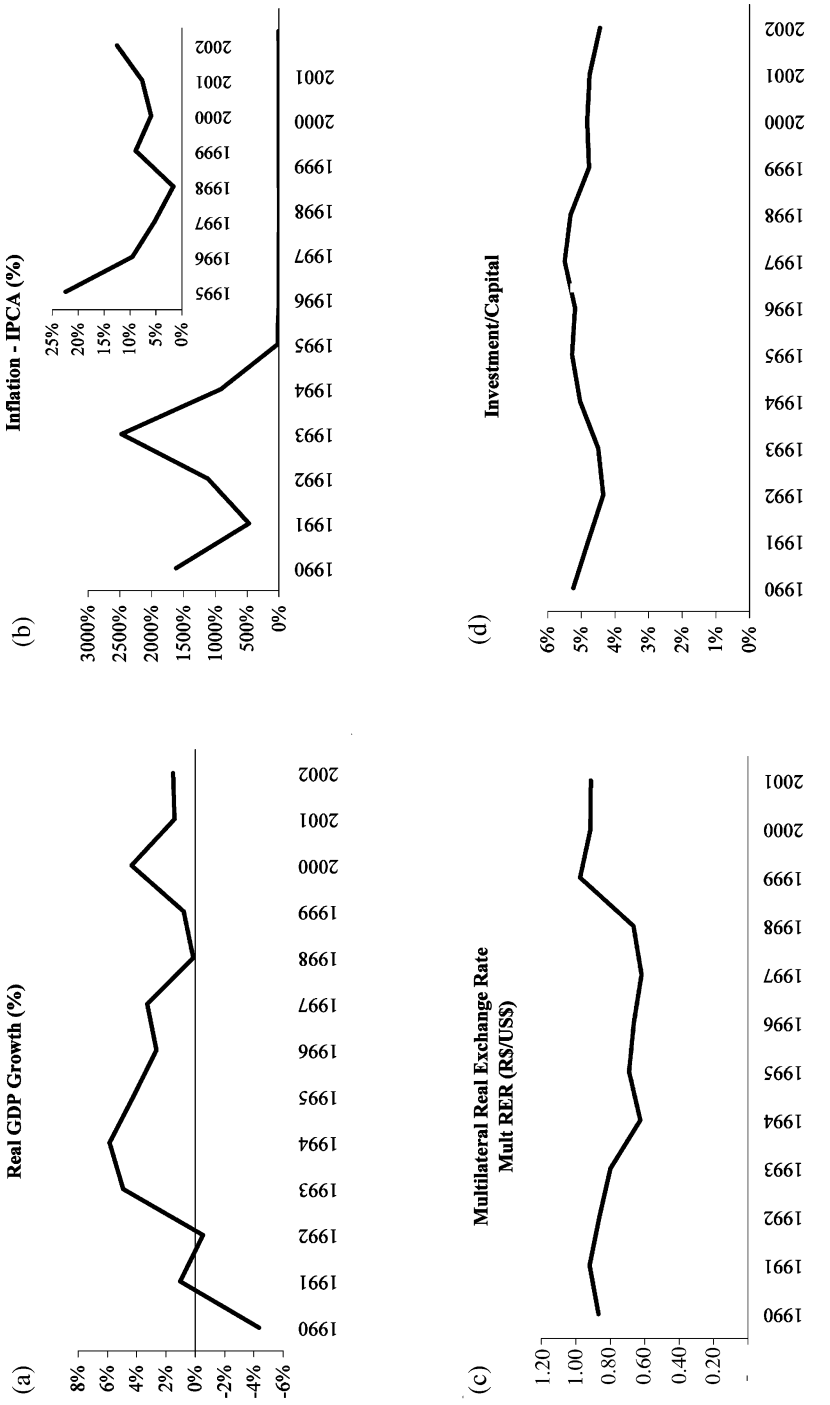

Fig. 1. Main macroeconomic variables.

When uncertainty about the sustainability of the crawling-peg exchange rate regime increased, firms started to hedge against the exchange rate devaluation risk. In January 1999, exchange rate was allowed to float. As a complement to the floating exchange rate regime, the Central Bank adopted an inflation-targeting framework for monetary policy in June. As a result exchange rate became much more volatile, although interest rate became less volatile. Under the free-floating regime, the risk of adoption of capital controls was reduced, which stimulated further the supply of foreign credit.

In this environment, firms had more incentive to bear interest rate risk and to hedge exchange rate risk. There are several instruments for hedging exchange rate risks in the Brazilian economy, such as exchange rate futures contracts, dollar indexed government bonds, swaps, dollar currency, foreign assets, etc. In the recent period, a frequent hedging mechanism used by firms is the acquisition of swaps from banks involving the exchange of interest in domestic currency for dollar-indexed payments. This mechanism is preferred because banks make tailor-made contracts according to the firm's necessity. However, banks are not exposed to exchange rate risk because they have dollar indexed government bonds in their portfolios. Thus, in net terms, hedge is provided by government with banks' intermediation.

In Fig. 2b, we can see that the proportion of the domestic federal debt securities indexed to the exchange rate more than doubled in 4 years, increasing from approximately 15% in December 1997 to approximately 33% in December 2001. This figure underestimates the increase in hedge since the Central Bank also offered exchange rate swaps attached to domestic currency.

Another important aspect is that because of the macroeconomic instability, there is no private supply of long-term loans for investment in Brazil. The main provider of long-term loans is the Brazilian National Development Bank (BNDES). These loans were indexed to inflation before stabilization. After the Real plan, inflation indexation with fixed interest rate was substituted by floating interest rate (named TJLP). This interest rate is decided by the National Monetary Council with base on the inflation target and Brazil's risk premium, and is lower and more stable than the market rates (see Fig. 2c.). Fig. 2d shows the proportion of BNDES loans in total loans to the private sector. It amounted to more than 12% of the total loans of the financial system by the end of 2001, which should correspond to a very large part of the long-term domestic loans.

During the whole period of analysis, the GDP had a stop and go pattern (Fig. 1a). There was a deep recession in the early nineties, caused by the Collor Plan (see Fig. 1a and Table 1). Then, the economy recovered and attained high growth rates in 1993 and 1994, and moderate rates from 1995 to 1997. As a result of the successive emerging market crisis and the anticipation of the Brazilian crisis, there was stagnation in 1998, and a timid recovery in 1999. The economy accelerated again to a 4.3% rate of growth in 2000. But contagion from Argentinean crisis, and the internal oil crisis caused another deceleration in 2001. In 2002 the perspective of a left victory in the elections was to blame for the mediocre performance, with growth rates approximately 1.5%. The aggregate investment rate, as a capital stock

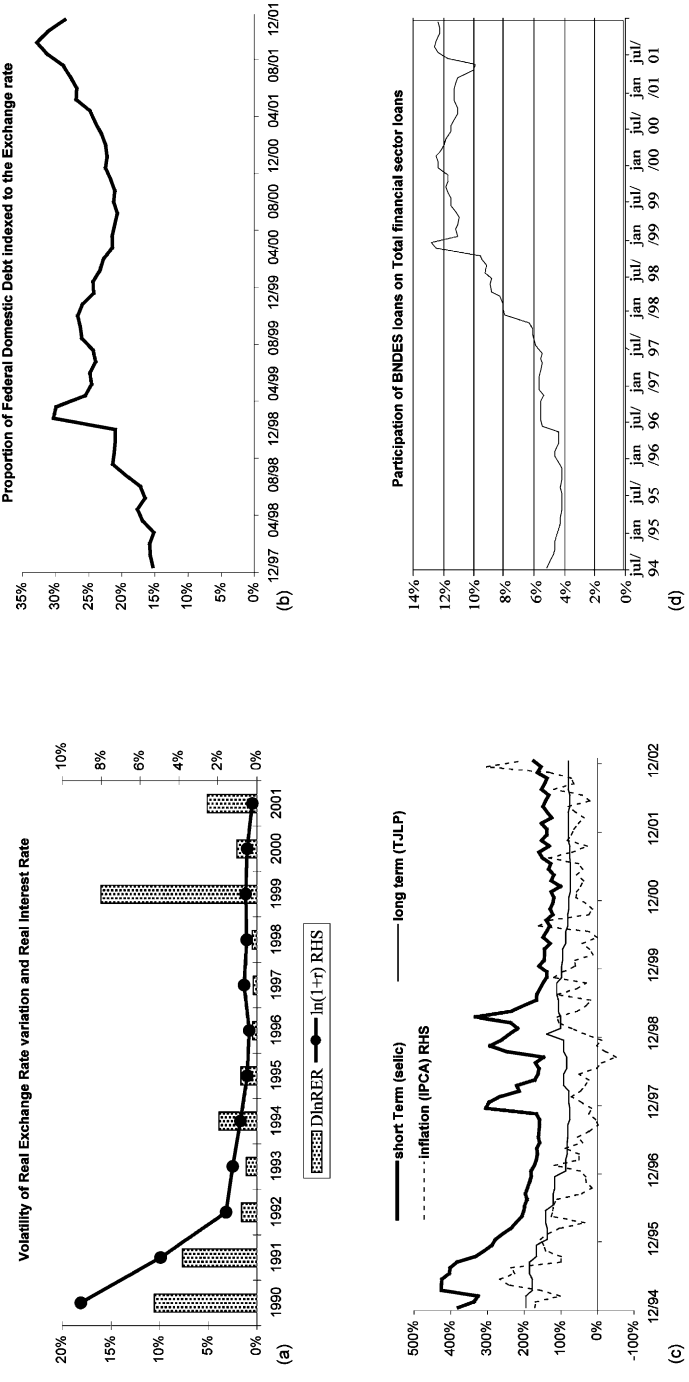

Fig. 2. Some relevant financial indicators.

Table 2
Number of firms in sample per year

1990	222
1991	214
1992	247
1993	274
1994	282
1995	286
1996	274
1997	280
199S	296
1999	283
2000	282
2001	262
2002	221
Total	3423

ratio, remained stable at approximately 5% (Fig. 1d): a mediocre rate engendered by the unstable macroeconomic environment.

3. Database description

This section describes the sample and variables under study. Our main data consist of firm-level accounting information for Brazilian non-financial corporations organized as a panel data set. The time period under investigation ranges from 1990 to 2002, with yearly observations.[3]

We started by using balance sheet data of a large sample of firms, provided by Austin Asis, of listed and unlisted companies. The use of the whole data set for investigating the above issues was not fruitful, possibly because unlisted firms balance sheets are not required to be audited in Brazil. Then, we decided to restrict our investigation to listed firms, using both the Austin Asis and Economatica data sets to construct our variables of interest and enlarge the number of observations in each regression.[4]

Additionally, we have data describing the firm's ownership structure and reported ADR issues collected from CVM, as well as measures of export orientation (exports/production) and imported inputs at industry level obtained at the FUNCEX.

In Table 2 we report the number of observations in the sample per year, which remains stable with an average of 263.3 firms per year. In Table 3, we report the mean and median for the variables (and its interactions) under estimation.

[3] Quarterly accounting numbers and monthly market variables are available and used in the construction of some variables.

[4] We used capital and debt variables from Austin and the remaining ones from Economatica. The number of observations in each regression was much smaller in earlier versions, where the balance sheet data were based only on Economatica.

Table 3
Descriptive statistics

	N.Obs	Mean	Median
Country level data			
ln(1+r)	3423	0.137	0.151
Δ ln(RER)	3423	0.020	0.021
σ(lnRER)	3423	0.059	0.025
σ(Δ lnRER)	3423	0.045	0.021
σ(IPCA)	3423	0.100	0.006
Finn Icvrl datii			
D^*/D_T	3423	0.136	0.000
D^*/K	3355	9.993	0.000
D_T/K	3355	34.559	0.398
I/K	3029	0.066	−8.970E-06
Q Tohin	2171	3.429	0.853
Sales/K	2978	1168.254	1.467
CF/K_{-1}	2978	146.333	0.088
Country and firm level data interactions			
D^*/K* Δ ln(RER)	3355	1.477	0.000
D_{LC}/K* ln(1+r)	3355	159.206	1.526
Exp*MultRER	2100	0.343	0.299
Imp*MultRER	2100	0.130	0.112

Our main dependent variable is *Investment*, measured as the change in net property and equipment added depreciation.[5] During the estimation procedure, all firm variables were calculated as ratios to capital stock measured as the net property and equipment at the beginning of the year. In the Appendix, we describe all the variables used in detail.

4. Methodology

Our investigation evolves around two issues. The first topic we study is the determinants of debt composition, focusing on currency denominated and maturity. Then we focus on the balance sheet effects of exchange rate on investment. The issues are interrelated since the balance sheet effect of exchange rate depends on currency denomination of debt.

4.1. Analysis of debt composition

In order to investigate the factors determining such changes, we estimate equations for the ratio of dollar-debt D^* over total debt D and of long-term debt D_{LT} over

[5] We experimented capital expenditures as a measure of investment, from Economatica, but the results were not qualitatively different, and there was a loss of significance because the number of observations in each regression was much smaller. Then, we moved back to capital stock differences in order to increase the number of observations. Additionally, Austin data set does not contain capital expenditures.

total debt D. We estimated the following equation:

$$r_{it} = c + \alpha m_t f_{it} + \beta f_{it} + y_t + \varepsilon_{it}$$

where r_{it} is a debt ratio, m_t's are variables capturing the macroeconomic environment and f_{it}'s are firms' individual features.

As r_{it} is necessarily between zero and one, the distribution of the right hand side variable is truncated, and tends to have atoms in the limits. We chose to estimate a Tobit model, which is an appealing specification when the range bounds have a relatively large proportion of observations. We checked that this was the case in our sample.

This equation is a reduced form and should reflect factors influencing both the demand and the supply for loans.

With imperfect capital markets, supply of funds becomes a relatively more important determinant of the debt composition. In particular, the availability of external funds depends on the liquidity of the international capital markets and on the international assessment of the country risk. Thus, the foreign supply of external debt is a key determinant of the dollar debt.

As for the demand of loans, one could think in a natural segmentation between short-term and long-term depending on its use. First one should try to match maturities in order to reduce risk. Thus, if the use is long-term investment, one should try to get long-term loans with fixed real interest rates because this would reduce its risk. If it is for working capital, one should get short-term loans. Although considerations of risk lead to a natural segmentation, important differences in costs or shortage of the desired type of loan could lead to mismatch. In Brazil, given the advantage in cost of a long-term subsidized BNDES loan, every firm that could qualify for it would prefer to use it than a short-term loan. The external funds are presumably more risky because of the exchange rate variation. The incentive to borrow in external currency would come either from the unavailability of domestic funds, as often happens for long-term loans, or from its lower cost. Even in this case, the use of the loan should play a role. External loans tend to be less risky in the context of export activities investment. It is also attractive if it is used to import inputs, since those have their prices set in dollars. Other consideration that should matter is the firm's ownership. An external loan is less risky in the perspective of a foreign shareholder, presuming that she has other assets in dollars. Thus, a foreign loan should be more attractive for a foreign owned firm. However, those differences should be less important in recent years when hedge against exchange rate fluctuations became widely available. In some periods, borrowing abroad and hedging domestically became cheaper than borrowing domestically. However, as in the case of domestic long-term loans, foreign loans were not accessible to all firms.

Finally, given the high level of interest rates, and the scarcity of long-term loans caused by the macroeconomic instability, firms' internal savings were presumably a very important source of funds for investment, especially before the stabilization.

For the foreign debt ratio equation we chose m as volatility of real exchange rate, and interacted it with size (proxied by log K). When r is the log-term debt ratio we

chose m as volatility of inflation, and also interacted it with size ($\log K$). We also tested the direct effect of having an ADR, being a foreign-owned firm, and belonging to the tradable sector. One would expect that volatility of RER would affect the risk of foreign debt, and that volatility of inflation would affect the risk of long-term debt. It is also expected that large firms have a better access to financial markets, and, therefore, could change their portfolios in response to a change in risk. Therefore, one would expect that an increase in the volatility of real exchange rate would reduce more the demand of foreign debt by large firms. Similarly, an increase in the volatility of inflation would reduce more the demand for long-term loans by large firms. In terms of the equation above, if demand is the prevailing effect on the debt rations, the coefficient α in both equations should be negative. We also expect a positive coefficient for the direct effect of our size proxy ($\log K$), and for the ADR dummy, since a larger firm and a firm that issued an ADR should have better access to the restricted foreign and long-term loan markets. One would also expect a positive coefficient for the foreign ownership and tradable sector dummies in the equation for the foreign currency debt ratio, since firms with those features have a better matching in terms of risk with foreign currency liabilities.

4.2. Investment and exchange rate balance sheet effects

Bleakley and Cowan (2002) investigated the balance sheet effect of exchange rate using a sample where more than a half of observations were due to Brazilian firms. They found that the effect of exchange rate devaluation was positive and statistically significant, which implies that balance sheet effects are not important. We intend to investigate this result by running different specifications of the investment equation.

We start by testing directly the balance sheet effects in some basic regressions. Then, we look at the role of capital market imperfections, firm heterogeneity and macroeconomic environment.

4.2.1. Basic regressions

Our strategy is first to test directly for the balance sheet effect of the exchange rate by running the following standard regression,

$$\frac{I_{i,t}}{K_{i,t-1}} = \alpha \frac{I_{i,t-1}}{K_{i,t-2}} + \gamma \frac{D^*_{i,t-1}}{K_{i,t-1}} \Delta \ \ln(RER)_t + \delta \frac{D^*_{i,t-1}}{K_{i,t-1}} + \varphi \frac{D_{i,t-1}}{K_{i,t-1}} + \eta_t + \mu_i + \varepsilon_{i,t} \qquad (1)$$

where I_{it} is the firm's investment, RER_t is the real exchange rate, η_t are year dummies and μ_i firms fixed effects. Our main focus is on the coefficient of the interaction between the real exchange rate depreciation and the debt in foreign currency. The total debt and debt in foreign currency are firm level controls. The year dummies intend to capture the variation of the macroeconomic environment through time. We also run the same equation adding sales (divided by capital) and cash flows (divided by capital) as firm level controls.

If this equation captures an exchange rate balance sheet effect, one would expect a negative coefficient for the interaction between the foreign currency debt and exchange rate devaluation. The interpretation is that exchange rate devaluations affect more adversely a firm with higher foreign debt. A necessary condition for this effect is the existence of capital market imperfections. When a positive sign is found, the usual interpretation (Bleakley and Cowan, 2002) is that exchange rate devaluation also entails a positive substitution effect, due to higher exports profitability, and that a firm with higher external debt is also more likely to experience a larger impact from this effect. When a negative coefficient is found, one could also attribute it to a negative substitution effect, which appeared because of the importance of imported inputs for the firms in the sample, if higher external debt and importance of imported inputs are related. In order to control for those effects, one could add exchange rate interactions with exports and imports in our explanatory variables. Since we did not have the proportion of exports and of imported inputs at firm level, we used industry level data for those variables.

Finally, one could also argue that those controls do not capture an important part of the substitution effect, because this should also be important for firms producing for the domestic market. In this case, devaluation should increase protection for domestic producers of tradable goods, and allow them to have a higher profit margin. As a consequence they would be more stimulated to invest. We will return to this issue in the next subsection.

The second important issue to consider is if the balance sheet effect of exchange rate was affected by changes in the macroeconomic environment. We evaluate if the balance sheet effects were affected by the two major macroeconomic reforms: the Real Plan, in 1994, and the change in the exchange rate regime, in 1999. For that we take the period of 1995 to 1998 as our basis period and add slope dummies for the balance sheet effects in the high inflation (1990–1994) and floating exchange rate (1999–2001) periods.

The exercise just proposed is based on particular priors of when the effects changed. Alternatively, we allow for a different effect of dollar debt for each year. In this case, if we divide the obtained coefficient by the exchange rate variation, we could obtain the coefficient of the interaction between exchange rate devaluation and dollar debt for each year. If these coefficients are constant, the points in the plot of debt coefficient for a year vs. exchange rate depreciation in the same year should be along a straight line.

4.2.2. Capital market imperfections

With perfect capital markets investment is determined without reference to financial factors. A standard formulation is due to Hayashi (1982), where investment demand is related to Tobin's q[6]—the ratio between investment market value and its replacement cost. Balance-sheet effect should affect firms' investment when market imperfections create a wedge between the cost of internal and external finance.

[6] In fact, theoretically what matter is the marginal q. Under certain assumptions the average q, which is empirically available may be used instead.

Then, if a firm's net worth is reduced, the external finance premium increases, affecting negative investment (see Bernanke and Gertler, 1995). As a consequence, a proxy for net worth should affect investment, given the same financial opportunities, which are captured by q.

For our purposes, controlling for q could be more fruitful, because under certain conditions all variables that could affect the profitability of investment can be subsumed in q. If exchange rate devaluation improves investment opportunities, for example, q should be increased. Then q should increase with devaluation for an export firm, and also for a firm which produces tradable goods for the domestic market. Conversely, devaluation should cause a decrease in q for a non-tradable firm largely dependent on imported inputs. Therefore, this control should be able to capture the competitiveness effect more widely than the ones based on exports and imported inputs. Another advantage is that q, being a forward-looking variable dependent on expectations, could also reflect the extent to which devaluation is believed to be temporary or permanent.

As we argued before, investment could be reduced as an effect of an exchange rate devaluation if a firm suffers financial distress because it is largely indebted in dollars, and this is the main effect we want to assess. However, this latter effect is due to capital market imperfections. If capital markets were perfect the balance sheet effect would not occur even if the firm were heavily indebted in dollars. However, the so-called competitiveness effect should be entirely captured by q. Then, controlling for q should allow us to separate the competitiveness and balance sheet effects. Therefore, in this context there is no further need of other terms related to export and import orientation or tradability in order to capture the competitiveness effect.

A usual proxy for net worth in the investment literature is cash flow.[7] Despite the importance of cash flow for investment, it does not capture in principle all the net worth effect of an exchange rate change variation. Although exchange rate devaluations tend to increase financial expenses of firms indebted in dollars, therefore affecting cash flow directly, it also increases debt. Thus, as shown by Bleakley and Cowan (2002), the increase in current expenses is only a part of the negative effect on net worth.

We start with a test of capital market imperfections—which is a necessary condition for a balance sheet effect—by evaluating the effect of cash flows on investment, after controlling for q. We run the following regression:

$$\frac{I_{i,t}}{K_{i,t-1}} = \alpha \frac{I_{i,t-1}}{K_{i,t-2}} + \lambda q_{\mathrm{it}} + \theta \frac{CF_{\mathrm{it}}}{K_{i,t-1}} + \eta_t + \mu_i + \varepsilon_{i,t} \tag{2}$$

where q_{it} and CF_{it} are Tobins q and cash flows for firm i at time t, respectively, and

[7] In Brazil, Terra (2003) studied capital market imperfections in a panel with firm level balance sheet data from 1986 to 1997. She found evidence that Brazilian firms were credit constrained with exception of large and multinational firms. However, she does not use q, because her sample includes unlisted firms. Then one could argue that investment opportunities were not adequately controlled, and therefore would be reflected in cash flows.

the other variables are as in the equation before. A positive and significant coefficient λ may be interpreted as evidence of capital market imperfections.

Then, we test for exchange rate balance sheet effects on investment using q to control for competitiveness effects, and adding external debt and total debt as additional controls. We run the regression:

$$\frac{I_{i,t}}{K_{i,t-1}} = \alpha \frac{I_{i,t-1}}{K_{i,t-2}} + \lambda q_{it} + \gamma \frac{D^*_{i,t-1}}{K_{i,t-1}} \Delta \ \ln(\mathrm{RER})_t + \delta \frac{D^*_{i,t-1}}{K_{i,t-1}} + \varphi \frac{D_{i,t-1}}{K_{i,t-1}} \eta_t + \mu_i + \varepsilon_{i,t} \qquad (3)$$

We then proceed with a more detailed investigation on the specific channels for the exchange rate balance sheet effect. First we test if there is an effect of exchange devaluation for firms highly indebted in dollars, even after controlling for other variables related to its financial net worth, as cash flow, level of debt and previous level of dollar debt.

It is in the tradition of the literature of capital market imperfections to test for differential effects among groups of firms. The idea is to select groups with base on characteristics related to access to capital markets. Then a hypothesis to be tested, for example, is that if the investment of the group with presumably less access to capital markets is more sensitive to cash flows. A natural extension to our setting would be then to test if the balance sheet effect is stronger for those groups of firms. We estimate the equation:

$$\begin{aligned}\frac{I_{i,t}}{K_{i,t-1}} = {} & \alpha \frac{I_{i,t-1}}{K_{i,t-2}} + \lambda q_{\mathrm{it}} + \chi q_{\mathrm{it}} \mathrm{SD}_i + \gamma \frac{D^*_{i,t-1}}{K_{i,t-1}} \Delta \ln(\mathrm{RER})_t \\ & + \psi \frac{D^*_{i,t-1}}{K_{i,t-1}} \Delta \ln(\mathrm{RER})_t \mathrm{SD}_i + \eta_t + \mu_i + \varepsilon_{i,t} \end{aligned} \qquad (4)$$

where SD is a dummy that is equal to one if a firm is small. We then test if ψ is significantly greater than zero, which could be interpreted as meaning that exchange rate balance sheet effects are more important for small firms.

It is natural to think that if exchange rate balance sheet effects are important, exchange rate depreciation will affect more negatively the cash flow of indebted firms. This could be the channel through which exchange rate devaluation has a negative balance sheet effect on investment. In order to test this hypothesis, we run the following regression:

$$CF_{i,t} = \alpha CF_{i,t-1} + \beta D^{FC}_{i,t-1} \Delta \ln(\mathrm{RER})_t + \gamma D^{FC}_{i,t-1} + \delta D_{i,t-1} + \eta_t + \mu_i + \varepsilon_{i,t}$$

However, cash flow is not only a financial variable. A firm in the tradable sector could benefit from the devaluation and produce more, despite having dollar debt and also being negatively affected by the devaluation. The effect on cash flow could be ambiguous in this case.

Table 4
Estimation of debt currency composition dependent variable: debt in foreign currency/total debt (D^*/D_T)

Ln(K)	**−0.391*****	**−0.517*****	**−0.518*****
	(0.051)	(0.062)	(0.062)
Ln(K)*σ(RER)	**−5.293*****	**−4.352*****	**−4.359*****
	(0.317)	(0.329)	(0.330)
ADR		**0.297*****	**0.298*****
		(0.052)	(0.052)
FO		**−0.099**	**−0.102**
		(0.102)	(0.102)
Tradable			**0.021**
			(0.047)
Constant	**−1.384*****	**−1.554*****	**−1.554*****
	(0.086)	(0.107)	(0.107)
Pseudo R^2	**8.7**%	**8.9**%	**8.9**%
N Obs	**3423**	**2704**	**2704**
LR	**373.830**	**299.180**	**299.380**
	(0.000)	(0.000)	(0.000)

4.2.3. Econometric methodology

In estimating the dynamic panel regressions above, we could not use an OLS estimator, since it will be seriously biased due to correlation of the lagged dependent variable with the individual specific effects. A usual technique for dealing with variables that are correlated with the error term is to instrument them.

The econometric method used in the paper is based on Arellano and Bond (1991) seminal work. The paper presents specifications and methodology that are applicable to estimate a dynamic model from panel data by generalized method of moments (GMM). The GMM was introduced by Hansen (1982) and its basic advantage is that requires specifications of moment conditions instead of the full model probability density. The Arellano and Bond instruments exploit optimally all the linear moment restrictions that follow from the assumption of no serial correlation in the errors and no strictly exogenous variables. Although the Arellano and Bond (1991) work specify all the feasible instruments, our estimation uses a more parsimonious approach, using just the second to sixth lags of differenced variables. We use first step estimators, because the parameter values of the two-step are underestimated. However, the Sargan test of overidentifying restriction for this estimator is not robust.

5. Results

We present below the results for the debt composition and investment regressions.

5.1. Debt composition

Table 4 reports the results of our Tobit regressions for the ratio of debt in foreign currency to total debt. In the first column, we have only size and the interaction

Table 5
Estimation of debt maturity composition dependent variable: long term debt/total debt (D_{LT}/D_T)

Ln(K)	**−0.040*****	**−0.047*****	**−0.040*****
	(0.013)	(0.014)	(0.014)
Ln(K)*s (inflation)	**−0.039**	**0.223*****	**0.189*****
	(0.029)	(0.066)	(0.066)
ADR		**0.098*****	**0.094*****
		(0.018)	(0.018)
FO		**0.003**	**0.010**
		(0.031)	(0.031)
Tradable			**−0.087**
			(0.015)
Constant	**0.355*****	**0.340*****	**0.409**
	(0.017)	(0.020)	(0.023)
Pseudo R2	**0.3%**	**1.9%**	**3.1%**
N Obs	**3422**	**2703**	**2703**
LR	**11.210**	**51.190**	**82.760**
	(0.004)	(0.000)	(0.000)

Standard deviations are in parentheses for parameters estimation.
P-values are reported in parentheses for test statistics.
Tobit Model Estimation, the lower limit level is set to be 0.

between the volatility of the real exchange rate and size as explanatory variables. The coefficient of the interaction between the volatility of the real exchange rate and size has the negative expected sign and is highly statistically significant. This can be interpreted as meaning that larger firms are more able to reduce foreign debt when its risk increased. However, the size variable has also a statistically significant negative coefficient, what is unexpected. Those results are maintained in the other regressions, when we add other firm level controls. In the second column, we add dummies for foreign owned firms and for firms with ADR's. The ADR dummy has the positive expected coefficient, statistically significant at 1%, while the coefficient of the foreign ownership dummy is not statistically significant. In the third column, we added a dummy for tradable sector. Its coefficient is not statistically different from zero, while the other coefficient estimates are qualitatively similar to those obtained in the former regressions.

Table 5 presents similar regressions for the ratio of long-term to total debt, the only change being that we now use volatility of inflation in the place of volatility of real exchange rate. In the first column, we have a negative and statistically significant coefficient for the interaction variable, which is the expected sign. The size coefficient is negative and statistically significant too. The latter result is maintained when we add other firm level controls, while the former result is reverted. That is when an ADR control is added the interaction coefficient becomes positive and statistically significant, meaning that a larger firm is more likely to have long-term debt when inflation is higher. The coefficient of the ADR dummy itself is always positive and statistically significant, while the foreign ownership coefficient is never significantly different from zero. The tradable coefficient is negative and statistically significant. The interpretation of all those results is more

troublesome. This is because in Brazil the National Development Bank is the main provider of long-term loans, and those loans tend to be subsidized. Then, the results could reflect more government policy than firms' choices. The positive coefficient of the interaction, for example, could mean that the government used to favor more large companies at the old high inflation times than now.

5.2. Investment and exchange rate balance sheet effect

We report below the results for the investment equations.

5.2.1. Basic regressions

Table 6 reports some basic regression aimed at capturing the balance sheet effect of exchange rates. In the first column, we have the Eq. (1) estimated by the GMM difference method. The interaction term is positive and not statistically significant. The foreign currency debt and total debt are not statistically significant either. The only statistically significant coefficient is the one of lagged investment, which indicates that a static specification would be inappropriate. The equation does not pass the Sargan test of overidentifying restrictions. The hypothesis that time dummy coefficients are all zero is not rejected either. As mentioned in Section 4, in this specification it is likely that the competitiveness result will also influence the coefficient of the interaction variable.

In the second column, we add cash flows and sales as additional controls, but the results do not change qualitatively: still the coefficient of the lagged investment coefficient is the only one that is statistically different from zero. Now the specification passes the Sargan test and the coefficients of the time dummies are jointly statistically significant at 5%. However, there is evidence of second-order autocorrelation in the errors.

Then, we add the interactions of multilateral exchange rate with exports and with input imports in the basic specification (Section 1), in order to capture the competitiveness effect, hoping that the coefficient of the interaction of exchange rate devaluation with foreign currency debt would now reflect mostly the balance sheet effect. Now this latter coefficient becomes negative, but it is not statistically significant. The coefficient of the interaction of exchange rate with input imports is negative and statistically significant at 5%, indicating that firms which import more inputs tend to reduce their investment more when there is an exchange rate devaluation. The coefficient of the interaction with exports has the unexpected negative sign, but is not statistically significant. The time-dummy coefficients are statistically significant at 10%. The specification does not pass the Sargan test, but this test is not robust for the one-step estimation procedure.

The issue of whether the balance sheet effects changed with the macroeconomic environment is tackled through the regressions in Table 7. In the first column, we have a variant of Eq. (1) where the coefficient of the interaction between exchange rate depreciation and foreign currency debt was allowed to vary in different periods. We take the 1995–1998 as our base period and include additional explanatory variables by multiplying period dummies (1990–1994 and 1999–2002) by the

Table 6
Dependent variable: I/K

$(I/K-1)-1$	**−0.414*****	**−0.393*****	**−0.424*****
	(0.020)	(4.05E-02)	(0.048)
$(D^*/K)-1$* Δ ln(RER)	**0.728**	**0.129**	**−0.109**
	(0.614)	(0.102)	(0.143)
Sls/K-1		**−1.980E-05**	
		(1.05E-03)	
CF/K-1		**2.926E-03**	
		(0.010)	
$(D^*/K)-1$	**0.013**	**1.600E-03**	**0.082***
	(0.011)	(0.003)	(0.049)
$(D/K)-1$	**−2.498E-04**	**5.240E-05**	**−2.880E-06**
	(2.25E-04)	(2.04E-04)	(3.27E-06)
Exp*MultRER			−0.177
			(0.226)
Imp*MultRER			−1.795**
			(0.722)
Constant	**4.731**	**8.407**	**−0.255****
	(5.288)	(8.400)	(0.102)
NObs	**2291**	**2291**	**1442**
Wald (time)	**6.853**	**21.510****	**16.490***
	(0.739)	(0.018)	(0.087)
AR(1)	**1.592**	**0.007**	**−2.295****
	(0.111)	(0.994)	(0.022)
AR(2)	**1.051**	**−2.832*****	**−1.536**
	(0.293)	(0.005)	(0.125)
Sargan	**1208.0*****	**35.10**	**500.30*****
	(0.000)	(1.000)	(0.000)

Standard errors are in parentheses for parameters estimation.

P-values are reported in parentheses for test statistics.

The dynamic panel estimation uses GMM difference estimators, which are based on Arellano and Bond (1991).

The used instruments have 2 to 6 lagged periods.

GMM results are one step estimates with heteroskedasticity-consistent standard errors and test statistics.

AR(1) and AR(2) are tests for first-order and second-order serial correlation, asymptotically N(0,1).

Time dummies are included in all equations.

The Wald (time) statistics tests the hypothesis that the time-dummy coefficients are jointly zero.

interaction between exchange rate variation and foreign currency debt. Now the interaction variable coefficient is positive and significantly different from zero at 1%, and the additional term for the 1999–2002 period is negative, and also significantly different from zero at 1%. Since both the coefficients have the same order of magnitude, this could be interpreted as meaning that there is a positive effect in the base period and a null effect in the 1999–2002 period. However, as warned before, those coefficients could also partially reflect the competitiveness effect. The equation does not pass the Sargan test, and the necessary hypothesis of no second order correlation in the errors is also violated.

Table 7
Dependent variable: I/K

$(I/K_{-1})_{-1}$	**−0.451*****	**−0.154**	$(I/K-1)-1$	**−0.451*****	**−0.141**	Δ ln(RER)	Ratio 1	Ratio 2
	(3.43E-02)	(0.096)		(3.45E-02)	(9.50E-02)			
$(D^*/K)_{-1}$* Δ ln(RER)	**1.574*****	**1.070***	$(D^*/K)-l\_D_{1990}$	**−3.03E-12**	**1.29E-15**	**−0.141**	**2.15E-11**	**−9.16E-15**
	(0.204)	(0.593)		(3.47E-12)	(1.38E-14)			
$(D^*/K)-1$* Δ ln(RER)*D1990–1994	**2.567**	**−7.446**	$(D^*/K-l\_D_{1991}$	**−5.16E-11**	**2.48E-14**	**0.096**	**−5.39E-10**	**2.59E-13**
	(5.13E-07)	(45.490)		(6.00E-11)	(2.26E-13)			
$(D^*/K)-1$* Δ ln(RER)*D1999–2002	**−1.500*****	**−1.215*****	$(D^*/K)-l\_D_{1992}$	**8.46E-12**	**−1.48E-14**	**−0.051**	**−1.67E-10**	**2.92E-13**
	(0.186)	(0.457)		(9.82E-12)	(3.00E-13)			
$(D^*/K)_{-1}$	**1.29E-03****	**0.061**	$(D^*/K)-l\_D_{1993}$	**−3.354**	**−0.063**	**0.021**	**−1.58E+02**	**−2.94E+00**
	(2.57E-10)	(0.053)		(3.901)	(1.019)			
$(D/K)_{-1}$	−1.10E-05	**0.000**	$(D^*/K)-l\_D_{1994}$	**−1.451**	**5.33E-15**	**−0.354**	**4.10E+00**	**−1.51E-14**
	(2.20E-12)	(0.000)		(1.964)	(1.12E-13)			
Exp*MultRER		**−0.038**	$(D^*/K)-l\_D_{1995}$	**0.607**	**−0.228**	**−0.063**	**−9.66E+00**	**3.63E+00**
		(0.217)		(0.647)	(0.632)			
Imp*MultRER		−1.447**	$(D^*/K)-l\_D_{1996}$	**0.112** ***	**0.159*****	**−0.025**	**−4.51E+00**	**−6.41E+00**
		(0.639)		(0.019)	(0.018)			
			$(D^*/K)-l\_D_{1997}$	**0.330**	**−0.229**	**0.021**	**1.61E+01**	**−1.11E+01**
				(0.443)	(0.243)			
			$(D^*/K)-l\_D_{1998}$	**0.123*****	**0.150*****	**0.063**	**1.95E+00**	**2.38E+00**
				(0.019)	(0.014)			
			$(D^*/K)-l\_D_{1999}$	**0.012**	**0.029*****	**0.306**	**3.99E-02**	**9.50E-02**
				(0.015)	(0.011)			
			$(D^*/K)-l\_D_{2000}$	**4.04E-03***	**1.00E-03**	**0.031**	**1.31E-01**	**3.30E-02**
				(0.002)	(0.003)			
			$(D^*/K)-1\_D_{2001}$	**9.60E-03***	**−4.00E-03**	**0.097**	**9.87E-02**	**−4.50E-02**
				(1.920)	(0.013)			
			$(D^*/K)-l\_D_{2002}$	**4.82E-14**	**1.72E-16**	**0.302**	**1.59E-13**	**5.67E-16**
				(0.946)	(0.000)			
			Exp*MultRER		**4.51E-04**			
					(0.224)			
			Imp*MultRER		**−1.357****			
					(0.633)			
			$(D/K)-1$	**−1.11E-05**	**−3.96E-06**			

				(9.77E-06)	(0.000)
Constant	**−0.223**	**−0.033**	Constant	**−0.222**	**−0.020**
	(0.000)	(0.038)		(0.216)	(0.037)
N	**2291**	**1442**	N	**2291**	**1442*****
Wald (time)	**19.420****	**10.830**	Wald (time)	**21.980****	**16.160**
	(0.035)	(0.371)		(0.015)	(0.095) *
AR(1)	**0.056**	**−1.728***	AR(1)	**0.097**	**745.200**
	(0.955)	(0.084)		(0.923)	(0.000)
AR(2)	**−2.635*****	**0.814**	AR(2)	**−2.723*****	**−1.648**
	(0.008)	(0.416)		(0.006)	(0.099)
Sargan	**3544.000*****	**772.800*****	Sargan	**3536.00*****	**0.29**

Standard errors are in parentheses for parameters estimation.
P-values are reported in parentheses for test statistics.
The dynamic panel estimation uses GMM difference estimators, which are based on Arellano and Bond (1991).
The used instruments have 2 to 6 lagged periods.
GMM results are one step estimates with heteroskedasticity-consistent standard errors and test statistics.
AR(1) and AR(2) are tests for first-order and second-order serial correlation, asymptotically N(0,1).
Time dummies are included in all equations.
The Wald (time) statistics tests the hypothesis that the time-dummy coefficients are jointly zero.
Ratio means the result of (estimated D* vs. year dummy coeficient/difference of Ln(RER)).

Then, we add export orientation and imported input variables for a better control for the competitiveness effect. Now the magnitude of the base period coefficient is decreased, as well as its statistically significance. The coefficient is now close to one, instead of 1.5, and its degree of significance decreased from 1 to 10%. The coefficient for the 1999–2002 period decreased less and still maintained its significance at 1% level. Now the sum of the two coefficients, which would capture the balance sheet effect in the floating exchange rate period is negative, as one would expect. Now, we cannot reject the hypothesis of no second order correlation in the errors, and the Sargan test statistics decreased substantially, although it still rejects the specification.

Our last exercise is to see how the foreign currency debt affected investment for each year. For this we have as explanatory variables the product of year dummies by foreign currency debt. The results are reported in the third column of results in Table 7. The coefficients vary in terms of sign, but the only ones that are statistically significant are positive: two at 1% and two at 10%. The fact that the coefficient is positive in a given year does not imply though that the balance sheet effect was positive, since an exchange rate appreciation could have happened that year. For this reason, we also report in another column the exchange rate depreciation in each year and the ratio between the estimated coefficient and the exchange rate variation. We see that this ratio varies in terms of magnitude and sign, without a clear pattern. The specification does not pass the Sargan test either. However, one should be careful in interpreting those results since there are no controls for the competitiveness effect.

Those are added in the fourth column. Now the Sargan test does not reject the specification, but the results do not change qualitatively.

5.2.2. Capital market imperfections and exchange rate balance sheet effect

In this subsection, we report the results obtained by following an approach inspired by the literature on investment and capital market imperfections. Table 8 presents the results. In the first column, we report the estimation result for Eq. (2), which can be considered a test of capital market imperfections. The coefficient of the q variable is not statistically significant, but the coefficient of cash flow is positive and statistically significant at 1% level. This could be interpreted and evidence in favor of imperfect capital markets, corroborating the findings of Terra (2003) for Brazil.

The existence of imperfect capital markets is a necessary condition for the exchange rate balance sheet effect. Thus, the next question is that if using q as a control for investment opportunities, which includes the competitiveness effect, we can capture the balance sheet effect. Thus, in the second column we run regression Eq. (3), which uses q, foreign currency debt and total debt as controls. The coefficient of the dollar debt–exchange rate interaction is negative this time, but is not statistically different from zero. We then add cash flow as an explanatory variable in the third column. The coefficient of the interaction variable is slightly reduced in magnitude, but continues to be negative and statistically insignificant,

Table 8

Dependent variable: I/K					Dependent variable: CF/K	
$(I/K-1)_{-1}$	**−0.001**	**0.005**	**0.006**	**−0.005**	$(CF/K)-1$	**1.488E-04**
	(0.040)	(0.030)	(0.029)	(0.027)		(5.84E-04)
Q Tobin	**4.07586E-05**	**−4.848E-05**	**−8.543E-05**	**−1.312E-04**	$(D^*/K)-1 * \Delta \ln(RER)$	**5.088E-01**
	(0.001)	(6.87E-04)	(7.24E-04)	(7.95E-04)		(2.690)
CF/K	**2.644E-04*****		**3.032E-04*****		$(D^*/K)-1$	**−0.150**
	(5.02E-05)		(0.000)			(0.386)
$(D^*/K)-1 * \Delta \ln(RER)$		**−2.554E-01**	**−0.202**	**−12.580***	$(D/K)-1$	**−2.142E-02*****
		(0.160)	(0.166)	(6.754)		(6.03E-04)
$(D^*/K)-1$		**0.113***	0.100			
		(0.066)	(0.064)			
$(D/K)-1$		**1.517E-05**	1.150E-05***			
		(1.31E-05)	(3.30E-06)			
Q Tobin* SD				**2.070E-06*****		
				(8.08E-07)		
$(D^*/K)-1* \Delta \ln(RER)$* SD				**12.741***		
				(6.818)		
Constant	**−0.384**	**−0.365**	**−0.383**	**−0.814***	Constant	**−1840.820**
	(0.265)	(0.266)	(0.266)	(0.475)		(1873.769)
N	**999**	**999**	**999**	**999**	N	**2273**
Wald (time)	**18.790****	**16.120***	**16.330***	13.230	Wald (time)	**7.628**
	(0.043)	(0.096)	(0.090)	(0.211)		(0.665)***
AR(1)	**−1.700**	**−1.613**	**−1.599**	**−1.950**	AR(1)	**−1.346**
	(0.089)	(0.107)	(0.110)	(0.051)		(0.178)
AR(2)	**1.441**	**1.374**	**1.326**	**1.551**	AR(2)	**−0.022**
	(0.150)	(0.169)	(0.185)	(0.121)		(0.983)
Sargan	**476.800*****	**466.000*****	**477.500*****	**74.380**	Sargan	**2.610**
	(0.000)	(0.000)	(0.000)	(1.000)		(1.000)

Standard errors are in parentheses for parameters estimation.
P-values are reported in parentheses for test statistics.
The dynamic panel estimation uses GMM difference estimators, which are based on Arellano and Bond (1991).
The used instruments have 2 to 6 lagged periods.
GMM results are one step estimates with heteroskedasticity-consistent standard errors and test statistics.
AR(1) and AR(2) are tests for first-order and second-order serial correlation, asymptotically N(0,1).
Time dummies are included in all equations.
The Wald (time) statistics tests the hypothesis that the time-dummy coefficients are jointly zero.

while the cash flow coefficient increases in magnitude and continues to be positive and statistically significant.

Following also the tradition of the imperfect capital market literature we then test if there is a heterogeneous exchange rate balance sheet effect among group of firms. We use a dummy, which is one for small firms and tested if the coefficients of the slope dummies for q and for the exchange rate-dollar debt interaction variable were significantly different from zero. We found a negative and non-significant coefficient for the q, and a positive and statistically coefficient for the q-slope dummy. The coefficient of the interaction variable was found to be negative and significant at 10%, and that for the interaction-slope dummy positive, of similar magnitude, and also significant at 10%. The findings suggest that large firms have negative exchange rate balance sheet effect and negligible sensitivity to q, while small firms are more sensitive to q and have negligible balance sheet effect. It is also remarkable the good fit of this equation, reflected in a Sargan test with *P*-value 1. We cannot reject the hypothesis that the time-dummy coefficients are all zero either.

Finally, we test if there are exchange rate balance sheet effects on cash flows. We run regression Eq. (4), which has cash flow as a dependent variable. The coefficient of the interaction variable is positive, but is not significantly different from zero. Nevertheless, the leverage variable is negative and statistically significant at 1% level. This contributes to a good fit, since the *P*-value of the Sargan test is 1.

6. Macroeconomic implications and final remarks

In our investigation, we encountered some limitations which prevented us from finding more robust results for the exchange rate balance sheet effect. The only robust result we found is that firms in industries with higher proportion of imported inputs tend to invest less when the exchange rate is depreciated.

A difficulty we faced is that an important part of the large firms in Brazil hedge against exchange rate variation, but individual measures of the hedged position are not available. Since we do not account for the hedge of those firms, the measured balance sheet effect for an average firm in the sample tend to be reduced, without implying that the effect is not important for non-hedged firms. In fact, the extent of capital market imperfections in Brazil makes us believe that this effect could be very strong at individual level, instead.

A question of natural interest is how important are the aggregate effects. Given the lack of robustness of our firm level exercise, it would be unsafe to do any macro calculations with base on those results. We could speculate that if large firms are mostly hedged and the majority of small firms do not have access to loans in foreign currency, the aggregate effect will not be important. However, since the government is the net provider of hedge for the private sector, exchange rate devaluations lead to deterioration of government's financial health, which, in an emerging market, generates a lot of instability.

An interesting macroeconomic question is how to compare a crawling peg regime, such as the one between 1995 and 1998, to the free floating regime from 1999 on.

In the former, the instability and public accounts deterioration was generated by the high and variable level of interest rates necessary to control the exchange rate. In the latter, the problem is engendered by the need or desire to hedge the private sector against exchange rate fluctuations. In both cases aggregate balance sheet effects should be small, but instability is there, caused by the original sin.

One could argue that the problem could be avoided in the free floating regime, if the government abstained from providing hedge to the private sector. Would we find then substantial exchange rate balance sheet effects? Without government intervention, hedge provided by the private sector would be substantially more expensive, and a firm before borrowing in foreign currency should take into account either the risk involved or the expensive cost of hedge.

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Appendix A: Description of the variables
Table A1
This table describes the variables used throughout the study

Variable	Description
Country level variables	
Nominal interest rate	Is the rate on loans issued by the financial sector. Corresponds to the *selic* rate on 30 days.
Real interest rate	Corresponds to the nominal interest rate adjusted by the inflation price index variation over the same time period.
Nominal exchange rate	Is the ratio between Real and US dollars, collected monthly, end of period.
Real exchange rate	Corresponds to the nominal exchange rate adjusted by the inflation price index.
Multilateral real exchange rate	Corresponds to the relative cost of a common basket of goods measured in terms of a common numeraire. We calculated a bilateral real exchange rate for each Brazilian trade partner as follows: $\mathrm{RER}_{(\mathrm{Brazil}/\mathrm{Country}_i)} = \frac{\frac{e_{\mathrm{Country}_i/\mathrm{USA}}}{e_{\mathrm{Brazil}/\mathrm{USA}}} \times \mathrm{WPI}_{\mathrm{Country}_i}}{\mathrm{WPI}_{\mathrm{Brazil}}}$ in which e corresponds to the nominal exchange rate between the countries and WPI corresponds to the wholesale price index. The multilateral real exchange rate is than an average of those bilateral exchange rates weighted by Brazilian international trade weights.
Inflation (IPCA)	A broad consumer price index, collected monthly. This index was used to deflate all variables in the study except investment. During the estimation procedure, we accumulated the monthly variation to construct the annual series.
Price level on investment	An investment price index used to deflate the investment variable. It is available in the Penn World Table.
Country-level constructed variables	
Real interest rate volatility $\sigma(\ln(1+r))$	It is the volatility of the log of the real interest rate, accumulated during the year.
Inflation price index variation Volatility-σ(IPCA)	It is the volatility of the broad consumer price index monthly variation.
Real exchange rate volatility-$\sigma(\Delta \ln \mathrm{RER})$	It is the volatility of the log of the real exchange rate.
Real exchange rate variation Volatility-$\sigma(\Delta \ln \mathrm{RER})$	It is the volatility of the log of the real exchange rate monthly variation.
Credit	Corresponds to the aggregated credit provided by the financial sector to the industrial sector divided by the GDP.
Industry level variables	
Exports orientation (Exp)	Corresponds to the ratio of exports to production, calculated annually at industry level.
Imported inputs (Imp)	Corresponds to the proportion of imported inputs, calculated annually at industry level.
Firm level variables	
Sales	It is a measure of total sales during the year.
Investment	It is a measure of the change in capital stock during the year to the capital stock at the beginning of the year, adjusted by the price level of investment.
Cash flow	Corresponds to the *Net Income* account accumulated during the year.

Table A1 *(Continued)*

Variable	Description
Debt in foreign currency	It is a measure of the stock of debt denominated in foreign currency converted into local currency (using the exchange rate for the period in which the balance sheet is reported) at the end of the year.
Tobin'Q	It is a measure of the firms' profitability constructed as the market value of assets divided by its the replacement cost. The numerator is the book value of assets minus the book value of common equity and deferred taxes plus the market value of common equity. The denominator is the book value of assets.
FO (Ownership structure)	It is a dummy variable that takes on a value of one if the firm has foreign ownership.
Tradable	It is a dummy variable that takes on a value of one if the firm is in a tradable industry (agriculture, food and beverage, manufacturing, mining, pulp and paper, oil and gas, chemical, vehicle and parts, transportation services
ADR	It is a dummy variable that takes on a value of one if the firm has issued an ADR in the US market.
SD	It's a dummy variable that takes the value of one if the firm's capital is smaller than the average database capital and zero otherwise.

The sources of macroeconomic data are: Brazilian Central Bank, IPEA database, FUNCEX (Center of International Commerce Studies) web site and IFS system.

The source of all firm-level variables used in the paper is Austin Asis database, except for the variables used in the construction of Tobin's Q that were collected from Economatica system.

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