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Working Paper 11/15

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The Open Economy Balance Sheet Channel and the Exporting Decisions of Firms: Evidence from the Brazilian Crisis of 1999

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September 2011

ABSTRACT

Many studies consider the aggregate impact of crises on output and the fiscal cost of reconstruction, but few studies of the impact of a crisis at the level of the firm. In this paper we consider the impact of the Brazilian crisis of 1999 on the extensive and intensive margin of exporters versus non-exporters. Using a unified theoretical framework based on a two-sector extension of the combined fixed and variable investment versions of the Holmström and Tirole (1997) closed-economy model, we explore predictors that firms will engage in global markets and export more intensively. Our results based on a detailed firm-level panel of data for Brazilian 52,667 firms from 1995-2007, show that the decision to export and increase export sales is driven by size, the debt ratio, the current ratio and operating costs as well as the direct impact of the crisis itself. The findings suggest that the mechanism is driven by the response of the credit market to the creditworthiness of the firm as it is by changing terms of trade.

JEL D21, D22, F14, F23

Keywords: credit channel, open economy, exports, currency crisis

1. Introduction

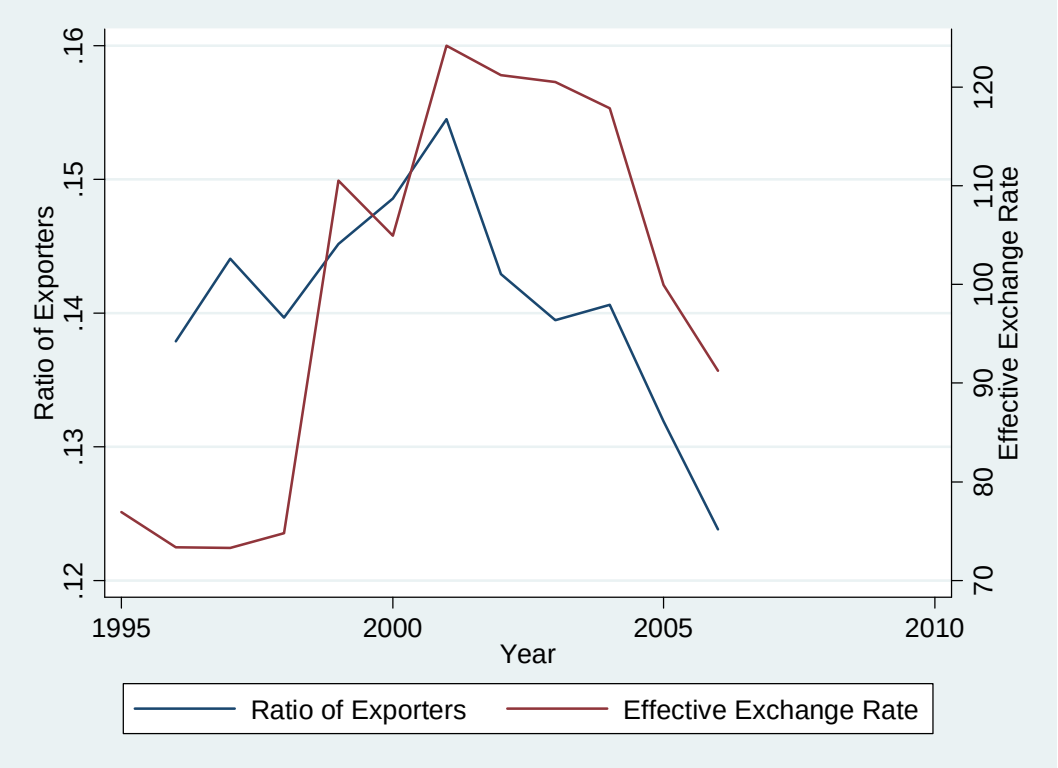
Financial crises have occurred regularly throughout the last 800 years, and share many similarities (Reinhart and Rogoff, 2009) but while some involve a collapse of the exchange rate regime alone (currency crises), others involve the banking and financial systems (banking crises), and still others combine both elements (twin-crises). Eichengreen and Bordo (2003) document that in the period 1880-1997 there were 258 crises in industrialized and emerging market countries, the majority (147) were currency crises, with roughly equal numbers of banking and twin crises (59 and 52 respectively). Some crises, like the East-Asian crisis of 1997, impacted output growth in one region of the world while others, like the most recent financial crisis, had a global impact. Allen and Gale (2004) document the financial costs of recent crises in the period 1977-2000 for 17 emerging countries and 7 developed countries, 9 of which were banking crises and 15 were twin crises. The fiscal costs of the resolution (as a percentage of GDP) was estimated to be 4.5% for banking crises and 23% for twin crises, showing that the latter had a costlier impact on the countries concerned. The impact of different types of crises on national output growth in terms of cumulative output losses was 5.6% for banking crises and 29.9% for twin crises, and twin crises took 4.2 years on average to resolve compared to 3.3 years to resolve banking crises.

Most studies evaluate the aggregate impact of crises in this way, by documenting the fiscal costs and lost output growth for the affected countries as a whole following different types of crisis events, but our paper is different. We consider how a crisis affects different types of firms within the crisis-affected country. Our focus is Brazil, where there was a well defined currency crisis in 1999 with its initial impact affecting the flow of foreign capital and the exchange rate market.[1] We consider how sudden exchange rate fluctuations affected the performance of firms that were exporters compared to those that were non-exporters. Movements in the exchange rate can affect both the cost of imported intermediate goods and the value of exports affecting the profitability of firms that sell goods abroad. Even if the overall performance of the economy did not reflect the turmoil in the foreign exchange rate market we would expect that the sudden fluctuations of the exchange rate might have effects on those firms that export their goods, and these might be different from the effects on firms

[1] The Brazilian crisis took place in the aftermath of the East-Asian crisis of 1997 and the Russian crisis of 1998 and followed a decade of strong capital inflows. The eruption of the two earlier crises triggered a reversal of capital flows in Brazil which eventually forced the government to float the Real on January 1999. However, the crisis was anticipated and as result the private sector had already, at least partially, hedged its positions which explains why the macroeconomic performance of the Brazilian economy did not significantly deteriorated during the crisis. For an excellent account of the crisis and its consequences for the Brazilian economy see Goldfajn (2000).

that satisfy only the domestic market. For example, while hedging might protect balance sheets and thus the ability of firms to raise funds externally, the depreciation of the currency might still boost the incentive to reach foreign markets. We can illustrate this point with reference to data on the movements of the effective exchange rate against the ratio of exporters to non-exporters for the period of our sample in Figure 1.

Figure 1: The Incentive to Export and the Effective Exchange Rate



Sources: Real Effective Exchange Rate: IPEA (Research Institute of Applied Economics, www.ipeadata.gov.br). Number of Exporters: SECEX (Brazilian Secretary of International Trade, http://www.desenvolvimento.gov.br). Number of firms: IBGE (Brazilian Institute of Economy and Geography, www.ibge.gov.br).

We can see that the ratio of exporters rose and fell with the real exchange rate, which shows that exchange rate fluctuations affect the *extensive margin* of international trade (the number of firms choosing to export). But such changes can also affect the *intensive margin* (the volume of sales of exporters) and the overall performance of exporting firms through their balance sheet. Moreover, they can also affect domestic firms through their impact on input costs. Therefore we examine in our paper the influences of the change in the exchange rate and other balance sheet variables that affected the ability of the firm to access export markets.

In order to analyze all these possibilities within a unified theoretical framework we consider a two-sector extension of the combined fixed and variable investment versions of the Holmström and Tirole (1997) closed-economy model.[2] Our first contribution is to modify this model to an open economy case, with exporters and non-exporters exposed to movements in the real exchange rate. In order to separate exporters from non-exporters we follow the modeling approach adopted in the international trade literature that introduces additional sunk costs for exporting firms.[3] All firms need to borrow in order to produce, and exporting requires greater resources. Given that our main goal is to understand the impact of shocks on firms following a currency crisis, through the exchange rate and the balance sheet, we focus on the interaction of firms with lenders in the financial markets.[4] We introduce both fixed and variable costs of production. Fixed costs create a threshold effect for net worth, such that firms with net worth below that threshold do not have access to external funds; variable costs allows for heterogeneity in investment levels once the decision to . Our model delivers a number of predictions relating the impact of the crisis on the exchange rate and on the balance sheet that affect the extensive and the intension margin. Our paper is therefore quite different from previous literature on the global engagement of firms, including papers by Arbeláez and Echavarría (2002), Campa and Shaver (2002), Castañeda (2002), De Brun, Gandelman and Barbieri (2002), Harrison and Macmillan (2003), Michiewizc et al. (2004) and more recently Guariglia and Mateut (2010), that do not attempt to provide a theoretical model to evaluate the impact of globalization on the decisions of the firm. However, it is complementary to it, since we engage in an empirical analysis of sales growth and the export participation decision of the firms.

We construct a detailed firm-level panel of data for Brazilian 52,667 firms from 1995-2007. The data is drawn from the SECEX database which gives the population of exporting firms in Brazil, which we combine with balance sheets and income statements reported by the Gazeta Mercantil and the Brazilian Institute of Geography and Statistics (IBGE). The real effective exchange rate was also provided by SECEX. This unique dataset allows us to

[2] Given that the stability of the Brazilian banking system was not severely affected by the crisis we simplify by focusing on a single source of finance thus ignoring the lending channel.

[3] There is a large international trade literature that makes a positive link between entry to export markets and firm size through sunk costs; see for example Bernard, Eaton, Jensen and Kortum (2003), Helpman, Melitz and Yeaple (2004) and Melitz (2003). Empirical support for this view is offered in Aw and Hwang (1995), Aw, Chung and Roberts (2000), Bernard and Jensen (2004), Girma, Greenaway and Kneller (2004), Greenaway, Guariglia and Kneller (2006), Roberts and Tybout (1997), and Tybout (2003).

[4] See Bougheas and Falvey (2011) for a general equilibrium version of a slight simplified version of the present model.

examine the impact of the crisis on exporters and non-exporters due to exchange rate fluctuations and balance sheet effects.

Our contribution is to explore the extensive margin using a probit model to estimate the probability that a firm will export its output conditional on the movement in the exchange rate and firm characteristics such as size, the debt ratio, current ratio and the inverse markup. We find that the extensive margin for Brazilian exporting firms as a proportion of all firms is negatively affected by increases in fixed and variable costs, and is positively influenced by movements in the real effective exchange rate. These findings confirm the predictions of our model based on an open economy credit channel framework in which movements in the exchange rate following the crisis have direct effects, and indirect effects through the balance sheet. Most previous literature on exporting firms takes the exporter v. non-exporter distinction as given, but here we model the decision to export itself.

We then explore the intensive margin using changes in sales growth for exporting and non-exporting firms. Using the same explanatory variables as before we investigate the impact of increases in balance sheet variables and the impact of the crisis in 1999 on sales growth. In addition, we confirm the results of Campa and Shaver (2001), Girma, Greenaway and Kneller (2004), Greenaway, Guariglia and Kneller (2006) and Guariglia and Mateut (2010), who find that exporters are on average larger in size and less financially constrained than non-exporters. Sales growth is highly responsive, and changes to growth indicate how business conditions are influential at the level of the firm. While we need to show some caution in the interpretation of total sales as a measure of the intensive margin, since growth could result from growing domestic sales as well as exports, we believe the impact on the domestic market would be more severe than on export markets because no competitive advantage results from the movement in the exchange rate in domestic sales, but import costs increase.

The paper is organized as follows. The next section develops the basic model. Sections 3 and 4 solve for the financial market equilibrium and analyze the impact of a currency crisis on the agents' choice of sector of employment and their decision to export. Section 5 develops our empirical methodology and describes our data sources. We present our results in Section 6 and Section 7 concludes.

2. The model

Our model has two periods (0, 1). Period 0 is the planning period when all financial contracts are agreed and investments are made. In period 1 the returns of all investments are realized and financial claims are settled. All agents are risk-neutral and they do not discount the future.

There are two countries: a small open economy (domestic economy) and the rest of the world. Let e denote the exchange rate (domestic currency units per unit of foreign currency). We assume that in period 0 the government pegs the exchange rate at $e = 1$ and that all agents expect that the peg will be maintained for the following period. In other words the economy is in its pre-crisis state with no prior knowledge of a crisis in the future.

There is a continuum of entrepreneurs of unit measure. Each entrepreneur is endowed with one unit of labor and some amount of assets, A. The only heterogeneity among entrepreneurs is their endowment of assets which is distributed on the interval $[0, \overline{A}]$. Let F denote the distribution function and f the corresponding density function.

The economy comprises of two final goods sectors; the output of the first sector is only consumed domestically, while the output of the second sector can either be consumed at home or exported. Accordingly we label the former 'domestic', and the latter 'exportable', keeping in mind that the decision to export is made by the entrepreneur. To keep things simple, we assume that the domestic good (numeraire) is produced under a CRS technology whereby production of one unit requires one unit of labor.

In contrast, the technology for producing the exportable good exhibits increasing returns. It needs to be managed by an entrepreneur who invests her endowments of labor and physical assets. The size of start-up capital required depends on whether or not the firm exports. Let K_D denote the size of the assets that must be invested by a firm producing only for the domestic market and $K_X (> K_D)$ denote the level of investment required by a firm that also exports part of its output. Assets are also used for the purchase of inputs, and these can be taken from domestic or foreign sources. The domestic and the foreign input are employed in fixed proportions. Let φ denote the fraction of the input from a domestic source. One unit of the domestic input costs one unit of assets while the unit cost of the foreign input is equal to one unit of foreign currency. Thus, as long as the peg is maintained the domestic currency unit cost of the composite input c is equal to 1.

Revenues of the exportable good are stochastic. Following Holmström and Tirole (1997), we assume that given the choice of fixed investment the technology is linear. However, the factor of proportionality is different between producers of exportable and non-

exportable goods. One reasonable interpretation is that the new higher fixed cost, in addition to covering costs related to the establishment of new markets also captures a reorganization of production encouraged by economies of scale related to the simultaneous production of goods for the domestic and foreign markets. Thus, with probability p an investment in the composite input of I units yields revenues $V_D I$when the firm produces only for the domestic market and revenues $V_X I (V_X > V_D)$ when the firm also exports. With probability $1-p$ the investment fails and yields nothing. These shocks are identical and independently distributed across firms. We further assume that an exporter's revenue from overseas sales is a fraction γ of total revenues.[5]

The probability of success depends on the behavior of the entrepreneur. When the entrepreneur exerts effort the probability of success is equal to p_H while when she shirks the probability of success is equal to $p_L (< p_H)$, however, in the latter case she derives an additional benefit, BI, which is proportional to the investment level.[6] Let $\Delta p \equiv p_H - p_L$. We assume that when the entrepreneur exerts effort the per unit of investment operating profit is positive, i.e. $p_H V > c$, and negative otherwise, i.e. $p_L V + B < c$, where $V \in \{V_D, V_X\}$. We impose the following restriction on the parameters of the model that ensures that the investment level is finite:

$$p_H \left(V - \frac{B}{\Delta p}\right) < 1; \quad where \quad V \in \{V_D, V_X\} \tag{1}$$

In this economy agents have potentially two choices. All agents much decide which good to produce. Those agents producing the domestic good lend their assets to other entrepreneurs that produce exportable goods, while those agents who produce the exportable good use their assets plus borrowed resources to invest to cover their fixed and variable costs. The second group of agents must also choose between producing only for the home market and producing also for the foreign market.

There is a credit market that channels funds from those producing the domestic good to those producing the exportable good. This market determines the equilibrium interest rate R. Assuming limited liability of the borrower the financial contract will specify that the two

[5] This is consistent with the evidence from the international trade literature showing that the volume of exports are proportional to firm size (see footnote 4).

[6] This is how Tirole (2006) interprets *B*: "The entrepreneur can "behave" ("work", "exert effort", "take no private benefit") or "misbehave" ("shirk", "take a private benefit"); or equivalently, the entrepreneur chooses between a project with a high probability of success and another project which ceteris paribus she prefers (is easier to implement, is more fun, has greater spinoffs in the future for the entrepreneur, benefits a friend, delivers perks, is more "glamorous," etc.) but has a lower probability of success." The proportionality assumption captures the idea that bigger investments offer more opportunities for misuse of funds. It happens to have a practical use since without it and given the linearity of the technology wealthy firms would be able to borrow an infinite amount of funds.

parties receive nothing when the project fails.[7] Let R_l denote the payment to the lender when the project succeeds which implies that the entrepreneur keeps $R_b \equiv VI - R_l$. Consider an entrepreneur with wealth A and total investment, $cI + K$. Noting that $V \in \{V_D, V_X\}$ and $K \in \{K_D, K_X\}$, the lender's zero-profit condition is given by $p_H R_l = (cI + K - A)R$ or

$$p_H(VI - R_b) = (cI + K - A)R \tag{2}$$

This assumes that the contract induces the entrepreneur to exert effort. The entrepreneur will exert effort if the following incentive compatibility constraint is satisfied $p_H R_b \geq p_L R_b + BI$ or

$$R_b = \frac{\Delta p}{BI} \tag{3}$$

By substituting (3) into (2) we get an upper bound for the level of investment.

$$I^* \equiv \frac{(A-K)R}{cR - p_H\left(V - \frac{B}{\Delta p}\right)} \tag{4}$$

Inequality (1) implies that the denominator of (4) is positive. The above inequality suggests that the entrepreneur must have sufficient assets to cover the initial fixed investment K. Beyond that level she can borrow a maximum $d \equiv k - 1$ times her level of remaining assets where $k \equiv \frac{R}{cR - p_H\left(V - \frac{B}{\Delta p}\right)}$. Any amount above this level violates incentive compatibility and the entrepreneur in that case will misuse the funds. Given that lenders make zero profits the entrepreneur's payoff is increasing in the level of investment and thus in equilibrium both (3) and (4) are satisfied as equalities. Thus an entrepreneur with an endowment of assets A can borrow an amount $I^* + K - A$.

3. Financial market equilibrium

In order to derive the financial market equilibrium we first need to allocate agents to their sector of employment and for those agents who manage firms in the exportable sector we also need a separation between those who produce only for the domestic market and those who also export. Below we will verify that our parameter restrictions imply that those agents with low endowments of assets will produce the domestic good, those agents with medium level endowments will produce the exportable good but will only be able to sell it in the domestic market and those agents with high endowments will produce the exportable good and sell it both domestically and abroad.

[7] Having the lender making a payment to the borrower will only weaken incentives and given that all agents are risk neutral (marginal utility of income is constant) there is no need for insurance.

3.1. Sector of employment choice

The income of an agent with an endowment of physical assets A who becomes an entrepreneur is equal to $p_H \frac{B}{\Delta p} I$. This follows from the fact that in equilibrium the incentive compatibility constraint is satisfied as an equality. The income of the same agent when she chooses the non-exportable goods sector for employment is equal to $1 + AR$ which comprises the earnings from domestic sales and the return from lending to producers of exportable goods. Setting the above two expressions equal (using (4) to substitute for I) and solving for A we find a threshold level of initial holdings of physical assets A^* such that all agents with $A > A^*$ produce the exportable good and all other agents produce the non-exportable good. The solution for A^* is given by

$$A^* = \left(\frac{p_H \frac{B}{\Delta p}}{p_H V_D - cR} \right) \left(\frac{1}{R} + K_D \right) - \frac{1}{R} \tag{5}$$

Condition (1) implies that the expression in the first bracket is bigger than 1. This, not surprisingly, implies that the threshold is increasing in the price of the non-exportable good. It is also increasing in agency costs as measured by B and the reciprocal of Δp. This is true because as these costs move up the number of agents that can gain access to external funds decreases. The remaining influence in the first bracket is the markup, which indicates the degree to which firms can raise prices above marginal costs due to market power or efficiency of operations. Lastly, the threshold also increases with the market interest rate as a higher rate encourages saving.

3.2. The choice to export

Given that the income of an entrepreneur is equal to $p_H \frac{B}{\Delta p} I$ we derive the threshold level of assets, $\tilde{A}$, that separates those who export from those who do not by equating their respective investment levels (by substituting their respective fixed cost and revenue parameters in (4)) and solve for A. The solution is given by

$$\tilde{A} = \frac{(K_X - K_D)\left(cR + p_H \frac{B}{\Delta p}\right) + p_H (K_D V_X - K_x V_D)}{p_H (V_X - V_D)} \tag{6}$$

An agent with wealth equal to $\tilde{A}$ is indifferent between producing only for the domestic market and producing goods for both markets. In the former case she borrows less given that (a) $K_D < K_X$, and (b) the investment levels are the same in the two cases, however, in the latter case revenues are higher so that profits in the two cases are the same.

3.3. Financial market equilibrium

Each producer of the primary commodity lends her endowment of assets while each producer of the manufacturing good borrows an amount equal to $I_i^* + K_i - A$, where $i = D, X$. Then the financial market clearing condition is given by

$$\int_0^{A^*} Af(A)dA = \int_{A^*}^{\tilde{A}} (cI_D^* + K_D - A)f(A)dA + \int_{\tilde{A}}^{\overline{A}} (cI_X^* + K_X - A)\, f(A)dA \qquad (7)$$

where the left-hand side equals the supply of funds, the first-term of the right hand-side equals the demand for funds by those producers of the manufacturing good that sell it only to the domestic market and the second-term equals the demand for funds by those who also export it. The system comprised of equations (5), (6) and (7) solves for the three endogenous variables A^*, $\tilde{A}$, and R, and thus solves for the equilibrium in the financial market.

4. Firm level adjustment to a currency crisis

Suppose that the government is forced to abandon the exchange rate peg. Let the new value of the exchange rate be $e = 1 + x$ so that $x > 0$ captures the rate of depreciation. Below we consider the implications of the depreciation of the currency for the financial market in general and individual firm behaviour in particular. We also consider both the immediate effects in the aftermath of the crisis and the long-run effects associated with currency depreciation. Clearly, the immediate effects are more dramatic as before the crisis many firms signed loan contracts on the expectation that the peg will be maintained.[8] The long-run effects are associated with contracts signed after the crisis and amount to a comparative statics exercise.

4.1. Immediate effects of the crisis

Floating the currency has an immediate impact on those firms that sign loan contracts immediately before the event. These firms now have with the same amount of funds to purchase the foreign input, but at a higher price in domestic currency units. Thus, the total amount of funds that they can use to purchase the composite input is still the same, but the number of units that these funds can purchase equals $\frac{I^*}{c}$. Given that the technology is linear it is reasonable to assume that expected revenues decline proportionately so that now are given by $p_h V \frac{I^*}{c}$. All firms that produce goods for the domestic market experience a decline in profits. Given that the obligations of all firms to their creditors are unaltered, those firms

[8]For those firms that managed to hedge their positions in the foreign exchange market the impact would have been less severe.

closer to the threshold A^* might not be able to repay their loans, and as a consequence go bankrupt. In contrast, the effect of the float on exporters is ambiguous because, even though they sell less output - which declines because inputs are more costly and fewer can be purchased with a given income - they do so at a higher price in the foreign market. This could result in a higher or a lower profit for the exporter.

4.2. Long-run effects of the currency depreciation

The depreciation of the currency has two direct effects on firms and one indirect effect. It directly affects (a) production costs, since the costs of imported materials rises, and (b) the revenues of exporters, since the value of foreign sales increases after the depreciation. It indirectly affects balance sheets through its effects on financial markets in general and interest rates in particular, since any change in interest rates affects how much manufacturing firms can borrow.

Following the depreciation the cost of a unit of the composite input c has risen from 1 to $1 + (1 - \varphi)x$. For those firms that produce only for the domestic market the implication is that investment declines (see (4)). Exporters alone reap the benefits of depreciation. Their revenues rise to $(1 + \gamma x)V_X$. The overall effect on their investment depends on the relative values of φ and γ.

In order to assess the effect of depreciation through its impact on financial markets we need to take into account the effects of depreciation on the two threshold levels of assets that separate (a) those producing exportable goods into those that service both the domestic and the foreign market from those that service only the domestic market, and (b) those that produce exportable goods from those that produce domestic goods. The direct effect of depreciation (the total effect would include the indirect effect on the equilibrium interest rate) on the first threshold, A^*, is to increase it since the increase in costs discourages agents to become entrepreneurs. The direct effect on the second threshold, $\tilde{A}$, is ambiguous since exporters face the same increase in costs but also benefit from an increase in revenues.

4.3. Predictions

Our model delivers a number of propositions that we will test using Brazilian firm-level data that span a period around the 1999 currency crisis. A key component in the discussion is the influence of agency costs. In our model agency costs are measured by the ratio $\frac{B}{\Delta p}$. As this ratio increases the amount of income that the borrower can pledge to her creditors declines

and thus provides a direct measure of financial constraints. We follow the corporate finance literature in using balance sheet variables to measure agency costs. Below we summarize our main predictions:

1. Both cut-off values, A^* and $\tilde{A}$, rise with an increase in agency costs, therefore probability of exporting, the level of investment, and sales growth decline as agency costs increase.

2. The cutoff value for initial holdings of physical assets sufficient to produce the exportable good, A^*, is increasing with a currency depreciation (cost effect) and the inverse of the markup (competition and efficiency).

3. Depreciation has an ambiguous effect on the cutoff value for initial holdings of physical assets sufficient to export the good, $\tilde{A}$, since exporting firms are less adversely affected by the depreciation and might even benefit.

4. Real activity such as investment and sales growth, is negatively affected by depreciation, and the negative effect of depreciation on sales growth for non-exporting firms is worse for firms with poorer balance sheets. For exporting firms the effect is ambiguous.

Therefore our model yields two types of predictions relating the movements of the exchange rate to the performance of Brazilian firms. First, there are predictions about the decision to export. Our model follows the international trade literature in predicting that larger firms that are also financially healthy are more likely to export. In addition, it also predicts that a depreciation of the exchange rate will further encourage the decision to export. This is a prediction about the extensive margin. Second there are predictions relating to the intensive margin, suggesting that sales of exporting firms will increase for larger financially healthy firms that export, and be less affected by a depreciation of the exchange rate in the crisis year. We are able to compare the performance of exporting firms to the sales performance of non-exporters in order to show exporters have greater sales. The next section explains the methodologies we use to explore the empirical evidence.

5. Methodology and Data

5.1. Empirical methodology

To explore the extensive margin we use probit estimations of the probability that a firm will export. Our theoretical model indicates that this will depend on the scale of the firm, its financial health and the effective exchange rate. We estimate the following probit model:

$$Prob(y = 1\backslash \boldsymbol{x}) = \int_{-\infty}^{x'\beta} \phi(t)dt = \Phi(\boldsymbol{x'\beta}) =$$

$$\Phi(\beta_0 + \beta_1 \ln TOTAL\ ASSETS + \beta_2 LONG\ RUN\ DEBT\ RATIO + \beta_3 INVERSE\ MARKUP\ +$$

$$\beta 4 CURRENT\ RATIO + \beta 5 EFFECTIVE\ EXCHANGE\ RATE \quad (8)$$

where Φ represents the cumulative standard normal distribution function. The dependent variable is the probability that a firm exports. On the right-hand side, in addition to the effective exchange rate, we have also included the following variables. *TOTAL ASSETS* is equal to the total book value of assets and we use it as a proxy for firm size. *LONG-RUN DEBT RATIO* is equal to the ratio of long-run debt to total assets and we use it as proxy for agency costs in our theoretical model. *INVERSE MARKUP* is equal to operational costs divided by revenue and is used as a proxy the ratio of variable costs over price (since Operational Costs)/(Reveue) = (Variable Costs * Quantity)/(Price*Quantity)), and the *CURRENT RATIO* is current assets over current liabilities. The model predicts that larger firms will be exporters, since they have sufficient assets to produce and export the good, so we expect a positive sign on *TOTAL ASSETS*. The agency costs tend to weigh on firms' ability to produce exportable goods, and therefore are expected to have a negative impact on the decision to export, and similarly, a higher value of the *INVERSE MARKUP* is likely to reduce the probability of exporting. The *CURRENT RATIO* tells us that firms have a higher proportion of liquid assets relative to liabilities, which could be due to the fact that firms hold higher liquid assets or access lower levels of debt. Either way the firms with higher current ratios are likely to be more financially constrained, and less likely to be exporters, therefore we expect a negative sign on this variable. The exchange rate depreciation is likely to make exporters more competitive, and therefore we expect a positive sign on this variable.

In order to assess if the impact of the crisis was different between exporters and non-exporters we have estimated the following sales growth regression model using the usual dynamic panel-data methodology (first difference GMM) developed by Arellano and Bond (1991) and Arellano and Bover (1995)

$$\Delta SALES =$$

$$(\beta_0 + \beta_1\ \Delta SALES_{-1} + \beta_2 \ln TOTAL\ ASSETS + \beta_3\ CURRENT\ ASSETS\ RATIO +$$

$$\beta 4\ INVERSE\ MARKUP + \beta 5\ DEBT\ RATIO \quad (9)$$

The first difference model controls for firm-specific effects and time-invariant influences, and allows for the potential endogeneity of regressors by using lagged variables. The dependent variable is equal to the logarithm of the change in sales between periods t and $t-1$. Our data set does not separate domestic sales from exports, but we do know the total

sales for firms that are exporters and for firms that are non-exporters. According to our model, total sales should behave differently for exporters and non-exporters and we can explore the sensitivity of total sales for each group of firms to measures of agency costs, scale and the exchange rate. On the right-hand side we have included the following variables: $\Delta SALES_{-1}$ is equal to the growth rate of lagged sales, ln *TOTAL ASSETS* is equal to the logarithm of total assets that we use as a proxy for firm size, *CURRENT ASSETS RATIO* is the ratio of current assets to total assets and *DEBT RATIO* is the ratio of total debt to total assets. We use the lag of these variables as an instrument in our regressions. The two variables are included as measures of agency costs. The inclusion of the current asset ratio is in accordance with the free cash-flow theory discussed by Fazarri et al (1988), Hoshi, Kashyap and Scharfstein (1993), Hubbard (1998), Bond *et al.* (2003), Guariglia (2008) and Guariglia and Carpenter (2008) according to which agency costs are positively related to excess liquidity and thus negatively related to investment and sales. The second is the leverage ratio and it is included because a firm's ability to raise external funds in any given period is limited by the debt it has already accumulated. While we need to show some caution in the interpretation of growth in total sales as a measure of the intensive margin, since we could observe growing domestic sales as well as exports, the impact on the domestic market of a crisis is likely to be more severe than on export markets because firms gain no competitive advantage from the movement in the exchange rate in domestic sales, but import costs increase.

5.2. Data

The data covers the period from 1995 to 2006 and comes from different sources. SECEX covers the population of exporter firms.[9] This data does not contain other firm characteristics. Therefore, using the CNPJ (Brazilian firms' identification number), this dataset is merged to a sample of balance sheets and income statements collected by Gazeta Mercantil.[10] Because the data from SECEX is the population of exporters, each firm in this sample can be classified as a non-exporter or an exporter. Other Brazilian data, such as national and industry-level data, are provided by IBGE (Brazilian Institute of Geography and Statistics).[11] The real effective exchange rate was also provided by SECEX.

[9] For more information, see http://www.desenvolvimento.gov.br/sitio/interna/interna.php?area=5&menu=1444&refr=603.
[10] For more information, see http://www.investnews.com.br/.
[11] See http://www.ibge.gov.br/home/.

We downloaded 52,667 balance sheets from Gazeta Mercantil, which collected balance sheets and income statements made public by firms in different newspapers.[12] Not all variables are reported by all firms. For instance, in some cases current assets, permanent assets and long run assets are available, but the reader has to add them up to obtain total assets. Since some noise was detected in the data, only firms that provided all of the following variables were kept: total assets, current assets, permanent assets, long run assets, current liabilities, long run liabilities, liquid patrimony (equity). The purpose was to check the consistency of the data: total assets must be equal to the sum of current assets, permanent assets and long run assets and also equal to the sum of current liabilities, long run liabilities and equity. That left us with 25,945 balance sheets. Of those, erroneous recording (negative values and extreme outliers) were detected and dropped. Note that the net revenue of the firm can be negative (this variable corresponds to gross sales revenue minus merchandise returned, taxes and other deductions). However, we only included positive values of the inverse markup in the estimations, losing 407 observations. Our final data has 25,060 observations. Since not every firm has every variable, not all of those could be used in the estimations, especially in the sales growth rate regression which uses lags as instruments.

Table 1 provides summary statistics for the firm-level variables we used in our estimations. The first observation to make is that there is considerable variation around the mean values, and standard errors are much larger than the mean values in most cases. Second, the average firm is located towards the lower end of the distribution for each variable measured in Table 1, but there are some very large firms as indicated by the maximum values of the variables in the final column. 41% of firms are exporters according to our data. The average firm in our panel has US$102 million in total assets, US$31.5 million current assets, US$34.1 million in loans of which US$13.5 (approximately one third) are short-term. Revenues of US$70.5 million are generated with US$19.1 million of costs.

6. Results

Table 2 presents the results of the probit estimations. We report the estimated coefficients and the marginal effects of the variables on the probability of export. Since the variables could be endogenously determined we report results using current and lagged values of our explanatory variables for the sake of robustness. We find that the firm size, the measure of agency costs

[12] Data for some firms was not provided in the Gazeta Mercantil database. These data have been excluded from our sample.

using the long-run debt ratio, and the inverse markup are all important determinants of the probability to export. Firms that are larger have a greater tendency to export, as predicted by our model, and many other studies focusing on the costs of establishing export sales networks (see Roberts and Tybout, 1997, Roberts *et al*, 1997, and Tybout, 2003). The marginal effects show that a one percent increase in total assets raises the probability of export by 0.094. Firms that have higher agency costs also are less likely to export since they have less ability to pledge income to their creditors – meaning that they are likely to be more financially constrained than other firms – and therefore are unlikely to obtain sufficient resources to export. We find a one percent increase in the debt ratio reduces the probability of export by 0.144. Empirically this confirms evidence from developing and developed countries through the financial constraints imposed on exporters versus non-exporters reported in Arbelaez and Echavarria (2002), Campa and Shaver (2002), Castañeda (2002), De Brun et al. (2002), Harrison and Macmillan (2003), Michiewizc et al. (2004) and Guariglia and Mateut (2010). The sensitivity of lenders to size and agency costs is entirely consistent with the theory and evidence on access to export markets reported in Bernard *et al.* (2003), Bernard and Jensen (2004), Campa (2004), Girma *et al*. (2004), Greenaway *et al.* (2006), Helpman *et al.* (2004), Roberts and Tybout (1997), Roberts *et al.* (1997) and Tybout (2003). We would expect a larger firm size and a healthy balance sheet to be key determinants of access to credit and a scale of operations sufficient to cover fixed costs, and therefore to raise the probability that the firm will export. The domestic focus of small firms' activities compared to the international export focus of larger firms makes size a key distinction as far as lenders are concerned in open economy credit channel models but this is also closely linked to the debt ratio. There are fewer incentives for financial intermediaries to lend to small firms but greater incentives to lend to large firms since they are more diversified financially and when they have access to global markets they have exposure to goods markets at different phases of the business cycle, stabilising cash flow and credit provision (Campa and Shaver, 2002, and Guariglia and Mateut, 2010).

The measure of the inverse of the markup reflects the extent to which the firm can raise price above marginal cost. This varies with the degree of competition that the firm faces and with operational efficiency. When the inverse of the markup increases, it raises the threshold for exporting, making it less likely that a firm will choose to export. We measure the effect using the ratio of operating costs to net revenue of firms and find it has a negative effect on the probability that a firm will export. The marginal effect of the cost ratio is -0.08.

The one off effect of the exchange rate depreciation on firms during the crisis is small, with a marginal effect on the export probability of just 0.001, but it is highly significant.

When we consider the model with lagged variables (reported in the second column) the marginal effects are almost identical, with the exception of the influence of the cost ratio, which has a greater effect on the probability of exporting in the lagged variable model. A third model reported in the third column of Table 2 includes the current ratio in the model, as a further measure of the influence of constraints. The current asset ratio measures the liquid assets of the firms and has a similar interpretation to cash-flow measure used by Bond et al (2003) or Guariglia and Mateut (2010) in investment equations. A higher ratio is an indicator of financial constraints, and would be regarded from our perspective as an indicator that the firm is less likely to export. We find indeed, that the effect of a 1% increase in the current ratio reduces the probability of a firm being an exporter by 0.02. This is a relatively small effect but highly significant.

Our probit results provide evidence in support of the open economy balance-sheet channel with respect to the extensive margin. There is a small effect operating directly through the movement in the real exchange rate and a more powerful indirect effect measured through the balance sheet. Next, we turn our attention to the results from the sales growth regressions that will allow us to test the predictions of our model relating to the intensive margin, namely, firm performance measured by the rate of growth of sales.

Table 3 present the total sales growth regression results to investigate the intensive margin. According to our model we would expect to see some differences between exporters and non-exporters, especially during a period of exchange rate fluctuations. Thus, we estimate separate regressions for each group of firms. We also follow common practice in the literature of splitting our samples to two groups according to firm size because, on average, smaller firms find access to external finance is difficult to achieve. Firms whose total assets were below the median of total assets are in the groups of smaller firms, while those whose total assets are above the median are in the group of larger firms.

We interpret our results for the full sample (Model 1) as follows. The negative coefficient on lagged sales growth indicates that there is a cyclical dynamic relationship in sales growth, similar to the results reported by Bond et al (2003), but the coefficient is mostly insignificant. Controlling for any cyclicality, we examine the influence of scale, balance sheet (agency costs), the markup, and the current asset ratio. Time dummies are included in our regression, but we report only the coefficient on the dummy for the crisis year, which has obvious importance for our model.

First, we observe that lagged firm size also has a significant negative effect on the current sales growth rate, which is in accordance with Caballero and Hammour (1994) who find that smaller firms grow faster. Later, in models 4 and 5 where we compare large and small firms, we find that larger firms are less sensitive to size than small firms, confirming this interpretation. Second, the current asset ratio measures the liquid assets of the firms and has a similar effect in our sales growth regressions to the cash-flow measure used by Bond et al (2003), where it had a negative and significant effect on sales growth and investment. They demonstrate that there is bi-directional causality between cash flow, investment and sales growth, with lags of each variable being able to predict the current values of the other variables. This suggests that cash flow measures and real activity measures such as sales growth and investment are interrelated at the firm level, although the intensity varies across countries. We confirm a negative and significant effect of current asset ratio on the sales growth of the firm. It is noticeable that there is a stronger negative relationship for firms that are exporters, suggesting that exporters are more sensitive to the level of current assets than non-exporters. Third, the inverse markup variable has a negative effect on the sales growth, since a higher value of the variable indicates lower market power due to greater competition and lower efficiency of operations. Fourth, **t**he debt ratio has a negligible effect on sales growth for the full sample. Our model suggests that firms with strong balance sheet positions face lower agency costs and can finance higher investment and production resulting in greater sales growth. This is in keeping with the Holmstrom and Tirole (1997) model structure adopted by us and many others. But Opler and Titmus (2004) find that high leverage firms tend to lose market share to more conservatively financed competitors, particularly in downturns, and we might expect that firms with a higher ratio of debt to assets would also lose market share in the face of a crisis. The insignificance of the coefficient on the debt ratio may be the balance between greater potential for production and sales and the negative impact of debt on sales following adverse conditions. Finally, we show that the initial effect of the crisis, measured by the 1999 year dummy, causes a deterioration in conditions with an adverse effect on sales growth. Again this is expected, but for some types of firms – the export-oriented firms – the depreciation of the currency after the crisis might improve real sales growth associated with foreign sales, so we now explore the impact on sales growth for firms that are exporters and non-exporters.

Comparing the models where we split small and large firms and exporters and non-exporters, we find that exporters are more sensitive to the indicators of liquidity (current asset ratio) and the inverse markup (competition) than non-exporters. Comparing Models 2 and 3

we find that the coefficients take larger negative and significant values for exporters compared to non-exporters in both cases. Subsequent models that split exporters and non-exporters by size (Models 6-9) show that exporters are sensitive to liquidity, and the inverse markup. The debt ratio remains insignificant, except for the case of smaller exporters where it gains some significance and has a negative impact on growth. Finally, the impact of the dummy for 1999 is significantly negative for all categories of firms. It is more strongly negative for non-exporters than for exporters (Models 2 and 3), possibly due to the fact that exporters were able to offset falling domestic sales after the crisis with greater export sales with an improvement in competitiveness.[13] The test for first- (second-) order serial correlation in the first-differenced residuals, *m1* and *m2*, which are asymptotically distributed as N(0,1) under the null of no serial correlation, also show the model to be satisfactory, since they do not reject the null.

In conclusion, our results show that the variables included in our model – size, agency costs, the inverse markup, liquidity and the crisis dummy – have an influence on the intensive margin based on growth in total sales.

7. Conclusions

There have been many studies of the aggregate impact of currency, banking and twin crises in terms of lost output and the fiscal cost of reconstruction, but few studies of the impact of a crisis at the level of the firm. Our paper complements much of the literature on performance of exporters and non-exporters using firm-level panels (c.f. Arbelaez and Echavarria, 2002, Campa and Shaver, 2002, Castañeda, 2002, De Brun et al., 2002, Harrison and Macmillan, 2003, Michiewizc et al., 2004, and Guariglia and Mateut, 2010), by looking at the impact of the Brazilian crisis of 1999 on the extensive and intensive margin of exporters versus non-exporters. Using a unified theoretical framework based on a two-sector extension of the combined fixed and variable investment versions of the Holmström and Tirole (1997) closed-economy model, we explore predictors that firms will engage in global markets and export more intensively. Our results based on a detailed firm-level panel of data for Brazilian 52,667 firms from 1995-2007, shows that the decision to export is driven by size, the debt ratio, the current ratio and costs as well as the direct impact of the crisis itself. The sales growth of exporting firms tends to respond to the same variables, but shows less sensitivity to the crisis than sales growth of non-exporting firms. The findings confirm that there is a mechanism that

[13] We have to infer this because we measure total sales growth not domestic and export sales growth separately.

influences the export decision and sales growth through the response of the credit market to the balance sheet characteristics of the firm.

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Table 1: Summary Statistics

Variable	N	Mean	SD	Min	Max
Exporter Ratio*	25,060	0.41	0.49	0	1
Total Assets (US $m)	25,060	102	732	4.5	46,900
Current Assets (US $m)	25,060	31.5	166	0.28	10,900
Long-Run Loans (US $m)	15,303	20.6	159	0	12,200
Short-Run Loans (US $m)	18,127	13.5	98.5	0	611,000
Costs (US $m)	19,389	19.1	43.9	0.28	160,000
Net Revenue (US $m)	23,136	70.5	405	-257	228,000
Inverse Markup	18,711	0.81	0.57	0	9.98
Long-Run Debt Ratio	15,303	0.13	0.2	0	5.46
Total Debt Ratio	13,646	0.23	0.29	0	10.68
Current Ratio	25,060	6.16	80.43	0	6573
Effective Exchange Rate	25,060	100.8	19.45	73.28	124.22

Note:* Dummy variable for export status equals to 1 if firm is an exporter

Table 2 – A probit model of the extensive margin

	Model 1	Marginal Effects	Model 1 - Lags	Marginal Effects	Model 2	Marginal Effects	Model 2 - Lags	Marginal Effects
Total Assets	0.235***	0.094***			0.223***	0.088***		
	(0.000)	(0.000)			(0.000)	(0.000)		
Total Assets (-1)			0.236***	0.094***			0.224***	0.089***
			(0.000)	(0.000)			(0.000)	(0.000)
Long-Run Debt Ratio	-0.362***	-0.144***			-0.377***	-0.149***		
	(0.000)	(0.000)			(0.000)	(0.000)		
Long-Run Debt Ratio (-1)			-0.357***	-0.142***			-0.370***	-0.147***
			(0.000)	(0.000)			(0.000)	(0.000)
Cost Ratio	-0.202***	-0.080***			-0.207***	-0.082***		
	(0.000)	(0.000)			(0.000)	(0.000)		
Cost Ratio (-1)			-0.238***	-0.095***			-0.244***	-0.097***
			(0.000)	(0.000)			(0.000)	(0.000)
Current Ratio					-0.053***	-0.021***		
					(0.000)	(0.000)		
Current Ratio (-1)							-0.054***	-0.021***
							(0.000)	(0.000)
Effective Exchange Rate	0.002***	0.001***	0.003***	0.001***	0.003***	0.001***	0.003***	0.001***
	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)
Constant	-4.004***		-4.017***		-3.694***		-3.693***	
	(0.000)		(0.000)		(0.000)		(0.000)	
Number of observations	11,549	11,549	8,525	8,525	11,549	11,549	8,525	8,525
Adjusted R2	0.042	0.042	0.041	0.041	0.052	0.052	0.050	0.050

Note: All specifications report the results of a probit model with test statistics and standard errors (in parentheses). * indicates significance at the 10% level. ** indicates significance at the 5% level. *** indicates significance at the 1% level.

Table 3 – A GMM model of the intensive margin

	Model 1: All Sample	Model 2 - Non-Exporters	Model 3 - Only Exporters	Model 4 - Smaller Firms	Model 5 - Larger Firms	Model 6 - Smaller Firms, Non-Exporters	Model 7 - Larger Firms, Non-Exporters	Model 8 - Smaller Firms, Exporters	Model 9 - Larger Firms, Exporters
DLSales	-0.057	-0.091	-0.042	-0.168***	-0.003	-0.185***	-0.050	-0.291***	0.052
	(0.305)	(0.231)	(0.409)	(0.003)	(0.973)	(0.009)	(0.688)	(0.009)	(0.138)
Total Assets	-0.221***	-0.216***	-0.211***	-0.270***	-0.168***	-0.355***	-0.026	-0.145	-0.235***
	(0.000)	(0.006)	(0.003)	(0.002)	(0.009)	(0.004)	(0.778)	(0.151)	(0.007)
Current Assets Ratio	-0.466***	-0.233	-0.673***	-0.613**	-0.299**	-0.359	-0.046	-0.761**	-0.474***
	(0.002)	(0.325)	(0.000)	(0.021)	(0.042)	(0.319)	(0.847)	(0.025)	(0.007)
Inverse Markup	-0.482***	-0.414***	-1.163***	-0.524***	-0.387**	-0.466***	-0.301	-1.281***	-1.159***
	(0.000)	(0.000)	(0.000)	(0.000)	(0.034)	(0.001)	(0.133)	(0.000)	(0.000)
Debt Ratio	-0.065	-0.004	-0.089	-0.149	0.030	0.050	-0.016	-0.264*	0.113
	(0.520)	(0.980)	(0.445)	(0.315)	(0.795)	(0.806)	(0.932)	(0.067)	(0.300)
Dummy Year 1999	-0.516***	-0.729***	-0.308***	-0.535***	-0.492***	-0.577***	-0.747***	-0.571***	-0.239***
	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)
Constant	4.557***	4.442***	4.835***	5.186***	3.667***	6.320***	1.267	3.955**	5.206***
	(0.000)	(0.001)	(0.000)	(0.000)	(0.002)	(0.002)	(0.442)	(0.020)	(0.001)
Number of observations	3,734	1,735	1,999	1,675		929	806	746	1,253
m1	-3.809	-2.545	-4.789	-4.851	-1.902	-4.013	-1.257	-2.146	-6.253
p-value	(0.000)	(0.011)	(0.000)	(0.000)	(0.057)	(0.000)	(0.209)	(0.032)	(0.000)
m2	-0.881	-1.686	-2.535	0.450	-1.948	-0.618	-1.553	-2.025	-1.439
p-value	(0.378)	(0.092)	(0.011)	(0.653)	(0.051)	(0.537)	(0.120)	(0.043)	(0.150)

Note: All specifications were estimated using a GMM first-difference specification. Test statistics and standard errors (in parentheses) are asymptotically robust to heteroskedasticity. *m1 (m2)* is a test for first- (second-) order serial correlation in the first-differenced residuals, asymptotically distributed as N(0,1) under the null of no serial correlation. The Sargan statistic is a test of the overidentifying restrictions, distributed as chi-square under the null of instrument validity. Instruments include first lags of all variables excepting dummy variables. Time dummies are included but not reported, with the exception of the crisis year 1999. * indicates significance at the 10% level. ** indicates significance at the 5% level. *** indicates significance at the 1% level.

Appendix (not intended for publication)

For the estimations only the balance sheets that provided values for all of the following variables were used: total assets, current assets, permanent assets, long run assets, current liabilities, long run liabilities and equity. This allowed us to eliminate those few cases where that violated the balance sheet restriction (a) total assets must be equal to the sum of current assets, permanent assets and long run assets (b) total liabilities are equal to current liabilities, long run liabilities and equity, and (c) total assets are equal to total liabilities. After eliminating outliers (see below) we were left with 25,060 observations.

Negative or zero current assets: 52 observation (among those, one observation is negative)

Negative long run assets: 10 observations

Negative or zero fixed assets: 15 observations

Negative current liabilities: 61 observations (among those, one observation is negative)

Negative liquid assets: 73 observations

Negative short run loans: 2 observations

Short run loans larger than current liabilities (short run loans is part of current liabilities): 18 observations

Negative long run loans: 5 observations

Long run loans larger than long run liabilities: 4 observations

Negative investments: 14 observations

Negative or zero costs: 27 observations

Negative net revenue: 11 observations

Negative cost ratio: 407 observations

Cost ratio larger than 10: 186 observations