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# Financial constraints and export performance: Evidence from Brazilian micro-data

Fatma Bouattour\*

University of Paris-Dauphine

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## Abstract

Despite the growing role of Brazil in international trade, exports still face challenges. Following the theoretical framework of Manova (2013), this paper provides firm-level evidence that financial constraints hamper the export performances. Using customs data from Brazil, I show through a probability model, that Large firms exhibit more probability to have export performances when compared with Small and Medium-sized firms, and that this advantage tends to decrease in industries with high external funding needs. The sectors' financial vulnerability is proxied with two measures borrowed from Rajan and Zingales (1998) and computed for Brazilian industries over the recent period of the 2000s. The results are globally robust to the modification of the proxies of sectoral external finance dependence, used in the literature. Other tests demonstrate that Brazilian subsidiaries have greater chances to be export performant, and that there is a "regional effect" that makes some Brazilian regions export more than others. This paper also provides an insight of the effects of the global crisis of 2008 on the export patterns.

**JEL Codes:** F10, F14, G30, L25

## 1 Introduction and motivation

Even with the growing role of Brazil as a global trader, it is widely recognized that export challenges persist. Over the last decade, the Brazilian economy has witnessed a strong export expansion. Brazilian exports of goods and services have grown 262 percent over the 2000s, significantly more than the average global expansion (Canuto et al, 2013). These performances are however found to be less stunning in comparison with other emerging countries, notably those of the BRICs. Despite the serious steps undertaken by the Brazilian government to the privatization and the growth maintain in the 1990s, Brazilian firms continue to face constraints which prevent them from export expansion. For instance, the traditional export promotion policies of the 1990s were voted to failure (Gusso et al, 2004). A major barrier for Brazilian

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\*PhD Student at the University of Paris-Dauphine and member of DIAL research team, co-directed by the University of Paris-Dauphine and the Institute of Research for Developement-France (IRD).

firms is the persistence of high costs of capital. The Brazilian financial system is featured by a lack of maturity and high interest rates. The availability of credit has been even more weakened due to the global economic crisis of 2008. This has led to a clear slowdown of the international trade. The proportion of Brazilian exports in the gross domestic product (GDP) shifted from 16.4 percent in 2004 to 11.2 percent in 2010. The Brazilian exports' diagnostic also shows differences between Brazilian sectors in terms of competitiveness. High-technology sectors are less performant when compared with primary and resourced-based sectors. This can be due to the importance of Brazil's natural resource endowments. An alternative explanation may be related to the differences in the access to credit between different industries. Beginning with Rajan and Zingales (1998), the recent literature on the impact of financial factors on the real outcomes has stressed that industries' characteristics affect their demand and access to external finance, which in consequence affect their performances. Despite the existence of rich literature on the effects of financial voids on economic growth, there exist only few studies focusing on export performances. Studies on the effects of credit constraints on exports are even more rarer at firm-level, due to the difficulty of obtaining detailed firm data.

This paper fills this void and proposes a deep analysis of the importance of financial frictions on the export performances, at firm-level. The analysis focuses on the intensive margin of trade. I pay special attention to the differences between manufacturing industries in the access to credit and the role of firms' characteristics, as well. Particularly, this work revisits the link between the firm size and the productivity level and the effects of the size on the firm's export performance. Given the international context after the global crisis and the Brazilian features, my analysis exploits customs data on the Brazilian exporting firms engaged in international trade in 2010. The data report the intervals of export values for exporting firms and unfortunately, the exact export values are not public. I crossed the information provided by the Brazilian customs with data on the industrial belonging of the exporting firms as well as firms' characteristics from different sources, notably, the Brazilian ministry of Finance (*Receita federal do Brasil*) and a private database ORBIS. Regarding the financial constraints at industry-level, I use two distinct indicators that I computed, in a previous work, for Brazilian publicly traded firms over the period 2000-2012. These indicators include the External Finance Dependence Index originally constructed by Rajan and Zingales (1998) for US firms and the level of Asset Tangibility. I build my empirical strategy following the predictions of the model of firm heterogeneity under credit constraints performed by Manova (2013). Due to the data characteristics, I use two econometric methods that deal with interval dependent variables: Interval regression which is an extension of the Tobit model and the Ordered Probit model. I find that large firms are more likely to have high export performances, compared to small and medium-sized firms. The results also indicate that financial frictions in the financing of their fixed and variable costs hamper the export

performance. In this paper, the financial frictions are mainly driven by the level of reliance on external finance, in the industry in which an exporting firm operates. The positive effect of the firm size on the export performances is found to be less influential in sectors with higher external capital needs. Other results include the importance of the legal status of the firm in Brazil, i.e. whether the firm is a main establishment in Brazil or a subsidiary. I then perform a series of robustness checks where I use proxies of industry's level of financial vulnerability borrowed from the literature. These measures include the Rajan and Zingales (1998)'s measure of reliance on external funds, computed for US industries over the 1980s, the update of this measure for the 1990s constructed by Kroszner et al (2007), the R&D intensity as well as the share of tangible assets in total assets. The findings are consistent with the results with Brazilian indicators. The exception is for the Rajan and Zingales (1998) measure for the 1980s. This can be justified by the differences in the industries' organization and needs, in the US over the 1980s and in Brazil in the recent period.

The remainder of the paper is organized as follows. The next section presents a comprehensive review of literature on the role of financial frictions in the performances of real outcomes, mainly related to international trade. I then present more precise literature with a focus on the Brazilian case. Section 4 provides the theoretical background. The paper then describes the data and presents descriptive statistics. The next section develops the empirical strategy. The following sections analyze the results and comment on the robustness checks. Finally, the paper concludes and offers suggestions about where further data collection and research would be useful.

## **2 Financial Factors and Exports: Review of Literature**

The past two decades have witnessed an increasing interest in the study of the link between financial factors and real outcomes. A number of theoretical and empirical researches have shed the light on the role of financial development in the economic growth (King and Levine, 1993; Rajan and Zingales, 1998; Bas and Berthou, 2012). A body of literature has also sought evidence on the impact of financial development on the exports at aggregate level. Starting with Kletzer and Bardhan (1987), a number of studies have confirmed the financial development gives a comparative advantage, when exporting, especially in industries with higher capital needs. Using industry-level data for 36 industries in 56 countries, Beck (2003) shows that countries with higher levels of financial development exhibit larger export shares and tend to specialize in industries with higher external financing needs. Hur et al (2006) find that well-functioning financial systems are determinants of international trade patterns, particularly for industries with larger parts of intangible assets. In line with these findings, Svaleryd and Vlachos (2005) confirm the link between financial systems and the patterns of international specialization, for OECD countries. The existent literature usually uses the amount of credit provided by the financial system to the private sector (as percentage of GDP)

as proxy for financial development. This assumes similar access to the external finance for firms within a country (Minetti and Zhu, 2011).

Recently, a growing body of literature has been interested in the effects of financial constraints on the international trade at firm-level. The importance of financial constraints for exporting companies can be assessed in different manners. Compared to domestic sellers, exporters face bigger liquidity constraints, as exports need generally a longer time lag between the production and the receipt of revenues. International activities incur also bigger risks. They are generally risks related to the lack of information on the foreign clients. Moreover, exporting activities require more fixed costs before entering the international market. These costs include the market exploration, the creation of subsidies in the foreign markets, etc. Melitz (2003) takes into account these costs and proposes a model of international trade, in which entering the export market requires the payment of up-front costs that can be seen as an investment. As confirmed in the literature, the financial health of firms affects their investments (Aghion et al, 2010). Consequently, their export decisions and performances may be tributary of their financial situations. Considering the importance of these arguments, Manova (2013) introduces liquidity constraints in a model of heterogeneous firms, *à la Melitz (2003)*. She assumes that exporters should borrow funds from the financial system to export and should present collaterals. The financial frictions affect the export participation (extensive margin of trade) and the export performances (intensive margin of trade). The effects are more pronounced for firms in sectors with higher external financing needs, especially in countries with poor financial institutions. Chaney (2013) also introduces credit frictions as determinants of exports at firm-level. He considers that liquidity constraints are linked to the firm's productivity: more productive firms have larger profits and then, they are less constrained. Despite these differences, both works have pointed the weight of firms' characteristics in the span of liquidity constraints they may face. Both authors have thus focused on the *demand* side of credit constraints. These theoretical contributions to the literature on international trade have been supported by empirical studies. Using data on a panel of UK manufacturing firms over the period 1993-2003, Greenway et al (2007) confirm that firms' financial health does matter for exporting decisions. Muûls (2008) shows that, credit constraints do matter for the exports of the Belgian manufacturing sector. The findings demonstrate that the firms which present higher productivity and less liquidity constraints are more likely to export. Berman and Héricourt (2008) provide evidence that liquidity constraints do affect exports in 9 emerging countries. To proxy the liquidity constraints, they use some variables and ratios from firms' balance-sheets. Similarly, Bricongne and al (2010) show that during the global crisis, the exports of French firms in more external-finance dependent sectors were more affected. Manova and others (2011) use detailed data on the Chinese firms that have international activities and show at micro-level that financial market vulnerability has a negative effect on the total amount of exports and reduces the number of destination

markets. Similar results are found in Minetti and Zhu (2011). The authors made a survey to get information on credit constraints and export volumes, in small and medium Italian firms. They define two measures that reflect two different intensities of credit rationing. Their results show that credit rationing reduces the export sales by more than the third. They also study the heterogeneous response of exporting firms by introducing dummies for firms and industries' characteristics. Their findings confirm that the effects of credit rationing on the participation to export and the overall sales, differ across firms and sectors. Paravisiani et al (2012) focus on the *supply* side of credits and studied the effects of bank funding shortages on the export performances of their related firms. The authors present a model that disentangles the effects of credit supply by banks from the effects of credit demand by firms, on the export activity. Based on the supply of credits during the crisis of 2008, they consider that the banks with large shares of foreign liabilities in their balance sheets, are more likely to face shortages in providing firms with credits. They use data on Peruvian banks and firms and estimate the elasticity of exports to credits. Their results show that a shrink in credit supply by the Peruvian banking system causes a reduction in export volumes but does not affect the extensive margin of trade. The authors also test the heterogeneous response of firms in different sectors and of different export flows, to the changes in the credit supply. Their estimations show a constant elasticity of exports to credit across the different characteristics of firms, sectors or export flows. Overall, the literature emphasized the importance of the financial development and the heterogeneity of sectors in terms of external finance dependence, in firms' access to credit. While the financial development refers to the supply side of credit, sectors' characteristics may affect both sides of credits. For instance, industries with higher R&D expenses are more dependent on external finance which positively affects their demand of credit. At the same time, the financial system may perceive it less risky to lend money to firms in "Growth" sectors (Rajan and Zingales, 1998) as they exhibit less liquidity constraints, and are less likely to default.

A part from financial factors, the literature made evidence about other variables that can be related to the liquidity constraints. Firm size has been considered as a factor that affects firm's financing patterns (Hadlock and Pierce, 2010). Demirgüç-Kunt and Maksimovic (1999) find that large firms have more long-term debt as a proportion of their total assets, compared to small firms, which shows that they have better access to external finance. Using data on US small firms in the 1980s, Levenson and Willard (2000) suggest that credit constrained firms are smaller, younger and more likely to be owned by their founders. More recently, other studies shed the light on the importance of firm ownership on its access to external funding. Furthermore, in standard heterogeneous firms trade models, firm size is generally considered to be positively correlated with firms' export performance, since both variables are driven by the productivity (Manova et al, 2011). Although tis relation between firm size, productivity and exports seems to be confirmed for US firms ( Bernard et al, 2007), one may

suggest that firms may differ by a number of dimensions that make the connection between firm size and productivity level questionable. This paper is an attempt to verify this relation for the Brazilian exporting firms. There may also be a "regional effect" that makes some regions more constrained than others (Kumar and Francisco, 2005). Within a country, urban cities have more access to banks and financial intermediaries. The level of development of the financial system networks in a given region positively impacts the supply of credit, and thus, it can be considered as a form of "relaxation" of the credit constraint.

### **3 Credit Constraints in International Trade: Brazilian Context**

The discussion on financial constraints is of special relevance for the Brazilian economy. The financial system in Brazil is featured by high interest rates, which are according to Hausman et al (2005), the reason behind the lack of performance of the Brazilian economy. The high costs of capital imply few profitable investments and are then considered as a financial barrier to growth. Claessens and Sakho (2013) argue however that it has been hard to disentangle the demand side from the supply side sources of the high interest rates. The high cost of capital can be due to the weak financial system and the inefficiency in intermediation as it can be the result of the lack of external capital demand from economic actors. While the supply side of credit can be traditionally assessed by analyzing the bank characteristics (Petersen and Rajan, 1995), the global financial crisis of 2008 has led to the emergence of new credit constraints. Alfaro et al (2014) study the effects of foreign capital restrictions imposed by the Brazilian government after the crisis and find that these restrictions negatively affect the availability of external finance and the investments, in consequence. Regarding the demand side of credit, a number of studies have sought evidence about whether Brazilian firms are credit constrained or not. Using panel data for Brazilian firms for the period 1986-1997, Terra (2003) find that investment decisions are affected by credit constraints and that Brazilian firms are indeed liquidity constrained. The findings show also that these effects are softer for multinational companies. Firm size is found to affect the financing constraints for Brazilian firms. Using a panel of 289 nonfinancial firms for the period 1995-2006, Crisostomo et al (2012) confirm that credit constraints impede firms' investments, especially for smaller firms. Investments of small firms are more reliant on internal funds, compared to large firms. In other words, this suggests that larger firms are more dependent on external finance compared to small firms. This finding may suggest that large firms will be more credit constrained in sectors that highly depend on external funds. Looking at the link between the firm size and the productivity level, trade models *à la Melitz* (2003) generally consider that there is a positive relationship between the firm size and the productivity level, which make more productive firms -and consequently larger firms- more export performant. This link has to be examined with caution for the case of Latin American Countries (LAC) and particularly for

Brazil. In fact, in these countries, governments have spent large amounts to finance programs to support Small and Medium Enterprises (SME), over the last decades, which may affect the productivity gap and the distribution of resources between SME and large firms (Ibarrarán et al, 2009). As a consequence, the relationship between firm size and productivity for these countries does not seem to be clear. In this paper, I study this question for the Brazilian case based on a theoretical framework *à la Melitz* (2003), in order to have a clear idea on the characteristics of the export behavior of Brazilian firms.

The existent literature on the link between credit constraints and investments for Brazilian firms is guided by the Brazilian context over the two past decades. In Brazil, there have been macroeconomic changes that can affect the access to credit. After a long period of economic underperformances, the 1990s were characterized by a number of reforms for the amelioration of financial conditions that were behind the changes in financial patterns of Brazilian firms (Studart, 2000). These reforms include mainly government actions to privatize industries and the banking sector. The banking reforms were about the establishment of universal banks and the privatization of State banks. These reforms resulted in a more flexible and sophisticated banking sector, which affects the behaviors at firm-level (Faleiros, 2013). In addition, the reforms concerned the foreign trade. An important action of Brazilian government towards external liberalization was observed. The combined effect of the signature of WTO agreement in the 1995 and the "Real" plan<sup>1</sup> was in favor of trade opening of the country. The role of government has consequently shifted from a monopoly to a regulator. Moreover, as for all the LAC, the Brazilian government has implemented programs aiming at relaxing financing constraints which are increasingly targeting SME, through the Brazilian Development Bank (BNDES). Despite these progresses and as presented in the beginning of this paragraph, Brazil still has relatively less developed financial system and high interest rates. These factors remain obstacles to the access to external financing, which negatively affects firms' investments. As exporting activities can be considered as corporate investments (Melitz, 2003), the export performances are dependent on the firm's credit constraints. According to the National Confederation of Industry in Brazil, access to finance is seen as one of the important barriers to exports for Brazilian exporters (see Appendix 1). Consistent with this fact, Araujo and Pianto (2010) argue that the novice exporting culture combined with the lack of credit, among others, can cause a firm to exit the export market. These facts result in a lower trade openness of Brazil, compared to other BRICS (Canuto et al, 2013).

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<sup>1</sup>The plan "Real" consists in a financial program initiated by the Brazilian government in the mid-1990s. This plan introduced a new currency "the Real" and an exchange rate that was partially linked to that of the US dollar, limited government spending and made other fiscal reforms.

#### 4 Theoretical framework: A model of heterogeneous firms with credit constraints

The literature on the link between credit constraints and the international trade suggested different theoretical frameworks that describe the activities of exporting firms and the mechanisms through which, they get external liquidity. In the prior literature, some authors consider that exporters need external capital to only finance the fixed costs related to the international trade activity; in this case, the credit constraints affect the selection of firms into exporting (extensive margin of trade) but not the level of their exports (intensive margin of trade). Other authors suggest that exporters finance both of their fixed and variable costs with external funds; in this case, credit constraints affect the two margins of trade. In this paper, I assume that firms can finance both their fixed and variable costs with external capital. Hence, financial constraints are expected to reduce both the extensive and intensive margins of trade. As presented in the theoretical literature, these effects are expected to be more pronounced in the more vulnerable sectors.

I consider the theoretical model of Manova (2013) which involves a firm-heterogeneity framework with  $N$  countries and  $S$  sectors. Within each sector  $s$ , heterogeneous firms produce varieties in country  $i$  different from those in country  $j$  and consumers love varieties and share the same CES utility function so that the utility function in country  $j$  is:

$$U_j = \prod_s \left[ \left( \int_{w \in \Omega_s} q_{js}(w)^{\frac{\varepsilon-1}{\varepsilon}} dw \right)^{\frac{\varepsilon}{\varepsilon-1}} \right]^{\eta_s}$$

Where  $q_{js}(w)$  is the consumption demand of the variety  $w$  of the sector  $s$  in country  $j$ ,  $\Omega_s$  is the set of varieties of differentiated products in sector  $s$  and  $\varepsilon > 1$  is the elasticity of substitution across varieties of the sector  $s$ .  $\eta_s$  is a parameter that indicates the share of the sector  $s$  in the total expenditure in country  $j$  and satisfies  $0 < \eta_s < 1$  and  $\sum_s \eta_s = 1$ .

The price index in country  $j$  takes the following form:

$$P_{js} = \left( \int_{w \in \Omega_s} p_{js}(w)^{1-\varepsilon} dw \right)^{\frac{1}{1-\varepsilon}}$$

with  $p_{js}(w)$  is the price of the variety  $w$  of the sector  $s$ . If  $Y_j$  is the total expenditure in country  $j$ , then, the demand for variety  $w$  of the sector  $s$  is:

$$q_{js}(w) = \frac{p_{js}(w)^{-\varepsilon} \cdot \eta_s}{P_{js}^{1-\varepsilon}} Y_j$$

Firms produce their products and sell them at the domestic market and can export them to other countries. The model assumes that the cost of producing one unit in the home market in sector  $s$  with productivity level  $a_{js}$  is  $c_{js}/a_{js}$  where  $c_{js}$  is a parameter that captures the

differences in terms of factor intensities between sectors and across countries. The fixed cost of entry in the domestic market is denoted  $c_{js} \cdot f_j$ . For simplicity, firms are supposed to finance their domestic activities by the cash flows of their operations. Consequently, only exporting activities require external liquidity. As in traditional trade models, it exists an iceberg trade cost  $\tau_{ij} > 1$ ; it follows that an exporter should export  $\tau_{ij} \cdot q_{ij}(a)$  so that  $q_{ij}(a)$  arrives at the importing country. Moreover, exporting from country  $i$  to country  $j$  require a fixed cost  $f_{ij} \geq 0$  where  $i \neq j$ .  $\tau_{ij}$  and  $f_{ij}$  are country-pair specific and the subscript  $i$  indicates the exporting country while  $j$  indicates the destination market. Firms are heterogeneous by their productivity level  $a_{js}$  which can be represented by the cumulative distribution function  $g(a)$  with support  $[a_l, a_h]$  with  $0 < a_l < a_h$ . The total costs to export,  $q_{ij}(a)$  are:

$$C_{ijs}(a) = q_{ij} \cdot \left( \frac{\tau_{ij} \cdot c_{js}}{a_{js}} \right) + c_{js} \cdot f_j$$

Manova (2013) also assumes that exporters are credit constrained. A firm cannot finance all its export costs internally; she needs to borrow a fraction  $d_s$  of its total costs related to the exporting activity. A firm borrows the capital from the financial system. Depending on the level of development of the financial system in the exporting country  $j$ , there exists a probability  $0 < \delta_j < 1$  that the contract is reinforced and that the borrower pays the repayment amount  $D(a)$ . In the opposite case, the financial system claims collateral.

The sectors in the economy are heterogeneous in terms of reliance on external capital. The more the sector depends on external liquidity, the more it is financially vulnerable. In a given sector, all firms have the same needs in terms of external capital and the same collateralizable assets. The model assumes that only a fraction  $z_s$  of the up-front costs goes to tangible assets (equipment, machines, lands, plants. . .) and can be collateralizable.

In the case of perfect financial systems, the firms, with a productivity level above a determined cut-off, can export, as predicted by Melitz (2003). Here, we add the financial constraints as determinants of the exporting decision. It is assumed that the productivity cut-off in the case of imperfect financial systems noted  $1/a_{ijs}^*$  is higher than the productivity cut-off in the absence of credit constraints  $1/a'_{ijs}$  so that  $1/a_{ijs}^* < 1/a'_{ijs}$ . Considering these assumptions, exporting firms from country  $j$  and operating in sector  $s$  will maximize their export profits by solving the following function:

$$\begin{aligned} Max \pi_{jis} = & p_{jis}(a) \cdot q_{jis}(a) - (1 - d_s) \cdot q_{jis}(a) \cdot \tau_{ji} \cdot c_{js} \cdot a - (1 - d_s) \cdot f_{ji} \cdot c_{js} \\ & - \delta_j \cdot F(a) - (1 - \delta_j) \cdot z_s \cdot c_{js} \cdot f_{ej} \end{aligned}$$

Subject to:

$$(1) \quad q_{jis}(a) = \frac{p_{jis}^{1-\varepsilon}(a) \cdot \theta_s \cdot Y_i}{P_{is}^{1-\varepsilon}}$$

Where  $\theta_s$  is the share of each sector in the total expenditure of the country,  $Y_i$  is the total income of the country  $i$  and  $P_{is}$  is price index in sector  $s$  in the country  $i$ .

$$(2) \quad A_{ijs}(a) = p_{jis}(a).q_{jis}(a) - (1 - d_s).q_{jis}(a).\tau_{ji}.c_{ji} - (1 - d_s).f_{ji}.c_{js} \geq F(a)$$

$$(3) \quad B_{ijs}(a) = -d_s.[q_{jis}(a).\tau_{ji}.c_{ji} + f_{ji}.c_{js}] + (1 - \delta_j).F(a) + \delta_j.z_s.c_{js}.f_{ji} \geq 0$$

In a context of financial constraints, the firms need external funds to invest in the exporting market. They borrow capital from the financial system. If the contract is enforced, the firms can offer at most the total amount of their net revenues to the creditor,  $A_{ijs}(a)$ . Similarly, the creditors will not provide firms with external funds unless their net returns  $B_{ijs}(a)$  are positive. With competitive credit markets, the bankers break even and in equilibrium  $B_{ijs}(a) = 0$ . Hence, the maximization problem of the firm is reduced to the firm's problem in the absence of credit constraints, but with one condition: the repayment amount  $F(a)$  cannot exceed the net revenue of the firm. More productive firms can sell larger quantities and have larger net revenues; however, since the repayment amount  $F(a)$  depends on the quantity, this will lead more productive firms to require larger amounts of external finance and then, larger  $F(a)$ . As a consequence, the export participation of the firms is characterized by two different cut-offs  $1/a^H$  and  $1/a^L$ . All firms with a productivity higher than  $1/a^L$  can export, but only those with a productivity higher than  $1/a^H$  will export at first-best, i.e. with quantities and prices of the maximization problem in the absence of credit constraints.  $1/a^H$  can be defined by  $A_{ijs}(a^H) = F(a^H)$ . Thus,  $1/a^H$  is the solution for:

$$\left[ 1 - (1 - d_s)\alpha - \frac{d_s\alpha}{\delta_j} \right] \cdot \left( \frac{\tau_{ij}c_{js}a_{ijs}^H}{\alpha P} \right)^{1-\varepsilon} \theta_s Y_i = \left( 1 - d_s + \frac{d_s}{\delta_j} \right) . f_{ji}.c_{js} - \frac{1 - \delta_j}{\delta_j} . z_s . c_{js} . f_{ji}$$

Manova (2013) shows that the productivity cut-off  $1/a^H$  is higher in countries with low level of financial development (assessed by the value of  $\delta_j$ ) and in sectors with high financial dependence on external finance  $d_s$ .

I recall that exporting larger quantities implies larger revenues and higher costs and thus, greater payments to the investor  $F(a)$ , as well. It follows that firms with productivities lower than  $1/a^H$  will be interested in exporting lower volumes than the unconstrained first-best level, at greater prices, to guarantee the same revenues  $A_{ijs}(a) = F(a)$ . The greatest price

$p^L(a)$  that firms can charge on their exports is the solution of maximization for the following equation:

$$\frac{p^{1-\varepsilon} \theta_s Y_i}{P^{1-\varepsilon}} \times \left[ 1 - (1 - d_s)\alpha + \frac{d_s \alpha}{\delta_j} \right] = \left( 1 - d_s + \frac{d_s}{\delta_j} \right) \cdot f_{ji} \cdot c_{js} - \frac{1-\delta_j}{\delta_j} \cdot z_s \cdot c_{js} \cdot f_{ji}$$

Exporters can then charge a price on their exports that can range from  $p^H(a) = \frac{\tau_{ij} c_{js} a_{ijs}}{\alpha}$  to  $p^L(a) = \frac{\tau_{ij} c_{js} a_{ijs}}{\alpha} \times \left( 1 - d_s + \frac{d_s}{\delta_j} \right)$  which is the price that maximizes the equation above. Using the expression of  $p^L(a)$ , the productivity cut-off  $1/a^L$  is defined by the following equation:

$$\left( 1 - d_s + \frac{d_s}{\delta_j} \right)^{1-\varepsilon} \cdot \left( \frac{\tau_{ij} c_{js} a_{ijs}^L}{\alpha P} \right)^{1-\varepsilon} \theta_s Y_i = \varepsilon \left[ \left( 1 - d_s + \frac{d_s}{\delta_j} \right) \cdot f_{ji} \cdot c_{js} - \frac{1-\delta_j}{\delta_j} \cdot z_s \cdot c_{js} \cdot f_{ji} \right]$$

One can show that the productivity cut-off  $1/a^L$  is systematically higher in financially less developed countries and in sectors which are more reliant on external funding. Note that these productivity cut-offs  $1/a^H$  and  $1/a^L$  define the proportion of the firms that can enter the exporting market in the presence of credit constraints, which is called the extensive margin of trade. Here, I am also interested in the value of exports of the individual firms, i.e. the *intensive* margin of trade. The value of exports of firm  $f$  from country  $j$  to country  $i$  in sector  $s$  is

$$\left\{ \begin{array}{l} \left( \frac{\tau_{ij} c_{js} a_{ijs}}{\alpha P} \right)^{1-\varepsilon} \theta_s Y_i \quad \text{for firms with } 1/a \geq 1/a^H \\ p(a) \cdot q(a) \quad \text{for firms with } 1/a^L \leq 1/a \leq 1/a^H \\ \text{where } \frac{\tau_{ij} c_{js} a_{ijs}}{\alpha} < p(a) \leq \frac{\tau_{ij} c_{js} a_{ijs}}{\alpha} \times \left( 1 - d_s + \frac{d_s}{\delta_j} \right) \\ \text{and } q(a) < \left( \frac{\tau_{ij} c_{js} a_{ijs}}{\alpha} \right)^{-\varepsilon} \frac{\theta_s Y_i}{P^{1-\varepsilon}} \text{ and that verifies } A_{ijs}(a) = F(a) \\ 0 \text{ otherwise} \end{array} \right\}$$

To summarize, the main prediction of this theoretical framework is that more productive firms are more export performant, and that the effect of a higher productivity level is more pronounced for firms operating in sectors that exhibit large needs in terms of external capital. In this study, the productivity level will be proxied by the firm size, following the basic idea in standard heterogeneous firm trade models (Manova et al, 2011).

## 5 Data

### 5.1 Sources

I use detailed data on Brazilian exporting firms in the year 2010. The data are gathered from different sources in order to construct a comprehensive database. Data on export values of Brazilian exporting firms have been collected by Secretariat of Foreign Trade SECEX- Brazilian Customs Authorities. The SECEX records every legally registered export transaction from Brazilian firms. For each transaction, the available information include the exporting firm (establishment level)<sup>2</sup>, identified by its unique 14-digit identifier CNPJ (*Cadastro Nacional de*

<sup>2</sup>Different establishments of a same company are considered as two distinct entities.

*Pessoa Jurídica*), the value of exports in US dollars, the country of destination, the exported product at the eight-digit NCM (*Nomenclatura Comum do Mercosul*). Unfortunately, I have no access to these detailed data. The information available includes the CNPJ identifier of the exporting firm, the Federal Unit in which the firm operates as well as the FOB total export range of value. The SECEX classifies the exporting firms according to their FOB export values in Million US \$ into five intervals as follows: Exports  $\leq$  1 million US\$, 1 million US\$  $\leq$  Exports  $\leq$  10 million US\$, 10 million US\$  $\leq$  Exports  $\leq$  50 million US\$, 50 million US\$  $\leq$  Exports  $\leq$  100 million US\$ and Exports  $\geq$  100 million US\$. I focus my empirical study on annual exports for the year 2010.

Since my aim is to take into account financial constraints at industry-level, I match the legal identifiers of the firms in my sample CNPJ with the sectors in which these firms mainly operate. This step required hand data collection. Data on the main economic activities of the exporting firms are collected from the Brazilian Ministry of Public Finance (*Receita Federal do Brazil*). The industries are classified following the Brazilian national classification of economic activities CNAE 2.0. Since a company can be pure import-export company that does not engage manufacturing, I restrict my sample to the exporting firms for which the main activity is a manufacturing one, i.e. in the subclasses ranging from 10 to 32. Note that a firm can export different products related to different sectors. Here, due to lack of data availability on the details about the different goods a firm exports, I assume that a firm's exports are of goods that correspond to her main economic activity. Although this assumption is restrictive, it does not bias our principal study concern which is to test how sector financial constraints affect the export performance of the firm. In general, the financial system only checks the main activity of a firm when deciding of the eligibility of the firm to getting a loan. By exploiting the same source of data, I have also collected data on the legal status of the firm, i.e. whether the firm is the main establishment in Brazil or a subsidiary. I use this information in order to capture the differences between parent firms and affiliate companies in the access to the external finance. Here, the term "parent" does not necessarily refer to the headquarter company ; it rather means the first establishment of a company (Brazilian or foreign) based in Brazil.

Data on firm size are obtained from the ORBIS database, a private database constructed by Bureau Van Dijk and gathering firm level data for over 7 million firms all over the world. The data available include four size indicators as follows: small, medium, large, and very large. The definition of the size is based on a number of proxies of size notably the number of employees and the firm turnover. These indicators are merged into two distinct indicators: Small and Medium firms, and Large firms (including large and very large ones).

Moving to the data on the industry measures of financial constraints, I use two Brazilian measures of sector reliance on external funding. The first and main measure is the external finance dependence (EFD) which is the share of capital expenditures that are not financed

by the cash flows from operations. This measure is an adaptation for Rajan and Zingales (1998) measures of external finance dependence calculated for the US sectors over the 80s, to Brazilian sectors over the recent period of time 2000-2012. The second measure is the level of asset tangibility of Brazilian industries computed over the same period. Both measures have been constructed in a previous work, and meant to be more coherent with the Brazilian context, in comparison with the indicators used in the literature (See Appendix 2).

I then subject these Brazilian measures to a number of robustness checks using industry measures of reliance on external finance directly borrowed from the literature on the effects of financial constraints. The first indicator is Rajan and Zingales (1998) measure of financial external dependence that is based on data for US publicly traded firms. This indicator corresponds to the median value of the average external finance dependence ratio over the 1980-1989. I also use the updated values of this indicator, from Kroszner et al (2007). The authors calculated the EFD indicators over 1980-1999. A third measure is the R&D intensity in an industry, defined as the share of R&D expenses in the total sales. In fact, R&D expenditures are incurred at the beginning of the production process and they are considered as up front fixed costs that are in general large costs especially when the product will be distributed in a foreign market (Manova, 2013). Moreover, we employ the ratio of inventories to sales which reflects the liquidity needs of the company. Note that this indicator reflects the liquidity needs in the short term. Finally, I make use of the asset tangibility indicator. This measure comes from Braun (2003) and shows that the financial vulnerability of the sector depends not only on the reliance of the sector on the external finance but also on the availability of hard assets. In fact, industries with fewer tangible assets have less assets to offer as collaterals for the financial system and then, are less likely to get external funds. This effect is more pronounced in the sectors that are more reliant on the external finance (Braun, 2003).

All these measures are computed for US firms and are supposed to capture the technological characteristics of each sector that make the manufacturing processes and up-front costs different across sectors. Furthermore, these differences are assumed to remain stable across countries (Rajan and Zingales, 1998; Braun, 2003). As presented in the standard literature, this assumption can be motivated by a number of arguments. First, the US have one of the most advanced financial systems which makes the US indicators reflect the optimal asset structure and firm's demand for external funds, in the absence of credit supply constraints. Second, the use of the US data as reference data can be suitable since it eliminates the potential endogeneity between the sector dependence on the external funds and the country's level of financial development or credit availability.

## 5.2 Descriptive Statistics

Before presenting the econometric analysis, I begin by presenting some descriptive statistics of the database on Brazilian exporting firms in Industrial sectors, in 2010, detailed in Ap-

pendix 3. The data available at SECEX cover all the exporting firms in the year 2010. The majority of these firms export less than 1 million US \$. Since the aim of the paper is to focus on manufacturing sectors, I restrict the sample to those firms that operate in industries of transformation according to CNAE 2.0 classification. These firms represent 64 percent of the whole sample of exporting companies, which accounts more than 20000 firms. Due to the lack of information on some explanatory variables, the final dataset covers 10266 exporting firms. The sector of machinery and equipment, CNAE 28, is the most present in this final sample with 14 percent of the sample. More than 80 percent of these firms export less than 1 million US \$.

When looking at the distribution of the firms in my sample, one can stand out two patterns. First, most of the firms that export in 2010 are small and medium sized firms. Only 4.5 percent of the exporting firms are very large firms. This fact can give the reader an idea about the organizational characteristics of Brazilian firms. Second, the exporting firms are likely to export less than 1 million US \$. Less than 2 percent of Brazilian exporters exhibit export performances that exceed 100 million US \$. Here, I precise that the most performant exporter in Brazil for the year 2010 is a subsidiary of Petrobras (*Petróleo Brasileiro S.A.*).

I then, look at the sectorial characteristics of the firms in my sample. I consider three groups<sup>3</sup> of sectors depending on the level of their external financing needs. I find that large and very large exporting firms are mainly operating in industries with medium and higher levels of reliance on external finance. On the other hand, small and medium exporting firms are firms operating in sectors with low and medium levels of external finance dependence. This pattern can be even more apparent when I consider RZ (1998) indicators of external finance dependence. These findings suggest a more facility for large firms to operate in sectors with higher dependence on external funds, compared to small and medium firms. This fact encourages me to sum the four firm size indicators into two sizes: Small and Medium firms, and Large firms. A final remark concerns the extensive margin of trade, i.e. firms that do not export in 2009 and that become exporters in 2010. Exporting firms in 2010 are mainly exporters in 2009. This may suggest the difficulties for a firm to become an exporter, which may be in relation with the importance of the up-front costs to be paid before entering the export market and the role of credit constraints in the ability to become an exporter (Manova, 2013).

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<sup>3</sup>The groups are defined by the 25th and the 75th percentiles of the values of the Brazilian external finance dependence indicator.

## 6 Empirical strategy

### 6.1 Basic Specification

The theoretical framework described above presents a number of predictions on the capacity of firms to enter the export market and to realize profits. Financial constraints including the financial development of the exporting country  $j$ , the reliance of the sector  $s$  on external funding and the firm  $f$ 's characteristics affect both the selection into exporting and the value of exports. Here, I focus on the intensive margin of trade, i.e. the value of exports. I begin by testing the prediction that the productivity cut-off for exporting, and thus the probability of having higher export values varies across sectors. I also take into account the importance of firm size as a determinant of firm exports. I define the following equation:

$$\text{LnExports}_f = \beta_0 + \beta_1 \cdot L_f + \beta_2 \cdot \text{FinVul}_s \times L_f + \varphi_s + \varepsilon$$

Here  $\text{LnExports}_f$  are the total value of export sales of firm  $f$  (in Log), in all industries and pooled across all of firm  $f$ 's export destinations.  $L_f$  is a firm size dummy, which takes the value of 1 for large firms, and 0 otherwise. Small and medium-sized firms are considered as the reference category.  $\text{FinVul}_s$  measures the sector  $s$ 's level of financial vulnerability in Brazil. I use two proxies for the financial vulnerability: the external finance dependence indicators for Brazilian manufacturing industries which are an adaptation of RZ's indicators for Brazil over the period 2000-2012 and the level of asset tangibility for Brazilian sectors computed over the same period. Finally,  $\varphi_s$  are sector dummies that capture all the characteristics inherent to the activity within an industrial sector. The sign of  $\beta_1$  is predicted to be positive confirming the effect of the firm size on the export performances. Large firms are supposed to be less constrained compared to small and medium ones and thus, they are supposed to be more performant in sectors with higher needs for external funds. The predicted sign of  $\beta_2$  is then positive. Note that these signs could be affected by the fact that the study concerns the Brazilian firms. As presented in the literature section, Brazilian large firms seem to be more credit constrained compared to SME, and that the Brazilian action to relax financing constraints seem to be directed towards SME rather than large firms, which may affect the link between firm size, productivity level, credit constraints and export performances. This empirical study is thus an attempt to verify the theoretical linkages for Brazilian firms.

### 6.2 Methodology

In order to test the empirical specification, and to deal with data features, I use two methods based on maximum likelihood estimation.

### 6.2.1 Tobit extension: Interval regression

Since the export values for Brazilian firms are only observed in intervals and that there is no information about the non-exporters, the main econometric specification in this paper is based on an extension of the Tobit model. The estimation of  $\beta$  parameters is driven by a maximum likelihood estimation. I note  $Y_f = LnExports_f$ . Then, the likelihood function is defined:

$$\begin{aligned}
L &= \prod_{Y_f < a} \left[ \Phi \left( \frac{a - X'_f \beta}{\sigma} \right) \right] \prod_{a < Y_f < b} \left[ \Phi \left( \frac{b - X'_f \beta}{\sigma} \right) - \Phi \left( \frac{a - X'_f \beta}{\sigma} \right) \right] \\
&\times \prod_{b < Y_f < c} \left[ \Phi \left( \frac{c - X'_f \beta}{\sigma} \right) - \Phi \left( \frac{b - X'_f \beta}{\sigma} \right) \right] \\
&\times \prod_{c < Y_f < d} \left[ \Phi \left( \frac{d - X'_f \beta}{\sigma} \right) - \Phi \left( \frac{c - X'_f \beta}{\sigma} \right) \right] \times \prod_{Y_f > d} \left[ 1 - \Phi \left( \frac{d - X'_f \beta}{\sigma} \right) \right]
\end{aligned}$$

where a, b, c and d are known cut-offs. The dependent variables are then the limits of the interval of export values (in Log) for each exporting firm in my sample.

### 6.2.2 Ordered Probit model

The dependent variable  $LnExports_f$  is considered as latent, since there are no available data on the exact values of exports at firm-level. I have however a categorical variable  $Class\ of\ Exports_j$  that is observed. There are five classes of exports in million US \$, ranging from 1 to 5, 5 being the higher class of exports. The equation defined in the empirical strategy can be then estimated with a probability Ordered Probit specification (see Appendix 4). The dependent variable is the probability for a Brazilian exporting firm to be in a given  $Class\ of\ Exports_j$ . The conditional probability of exporting in a given  $Class\ of\ Exports_j$  will be defined as follows:

$$P(Class\ of\ Exports_j | Observed\ variables)_f = \beta_0 + \beta_1 \cdot L_f + \beta_2 \cdot FinVul_s \times L_f + \varphi_s + \varepsilon_{fs}$$

Where:

$$Class\ of\ Exports_1 = 1 \text{ if } LnExports_f \leq \mu_1$$

$$Class\ of\ Exports_2 = 2 \text{ if } \mu_1 \leq LnExports_f \leq \mu_2$$

$$Class\ of\ Exports_3 = 3 \text{ if } \mu_2 \leq LnExports_f \leq \mu_3$$

$$Class\ of\ Exports_4 = 4 \text{ if } \mu_3 \leq LnExports_f \leq \mu_4$$

$$Class\ of\ Exports_5 = 5 \text{ if } LnExports_f \geq \mu_4$$

The  $\mu$ 's are unobserved thresholds to be estimated with  $\beta$ . They are values of exports that make the difference between two different categories, here classes of exports. Ordered Probit estimation assumes that the  $\varepsilon_{fs}$  is normally distributed across observations and I normalize the mean and the variance of  $\varepsilon_{fs}$  to zero and one, so that  $\varepsilon_{fs} \rightsquigarrow N(0, 1)$ .

## 7 Results

In this section, I begin by presenting the estimation results on the effect of the firm size and the industry's level of financial vulnerability on the export performances. I will focus on the results of the Interval regression method, since it better exploits the available data. The financial dependence of the sector is proxied by the Brazilian indicator of dependence on external finance and the ratio of asset tangibility, computed for the recent period of 2000-2012. In Table 1, I display the basic regression results in column 1; other columns present the results of augmented specifications, where I add some variables of control that may be linked to the financial constraints<sup>4</sup>. The results show that large firms are more likely to earn higher export revenues than small and medium ones and that this effect is less powerful in sectors with higher levels of dependence on external funds<sup>5</sup>. As expected, the size has a positive effect on the export performances of Brazilian companies: larger firms are supposed to be less constrained and as a result, they are more likely to export larger values. This finding is in line with the predictions of Melitz (2003). Since large firms are in general more productive, these firms will be more likely to perform when entering the export market. This lead is however found to be less pronounced in sectors with higher requirements for outside capital. Inconsistently with the idea that large firms may be less constrained and thus more likely to enter industries with higher needs of external funds, Brazilian large firms do not seem to be more performant in terms of exports, when they operate in sectors with higher external financing needs, compared to small and medium firms. This finding can be supported by the limited access to credit due to the situation of the Brazilian financial market. In fact, despite the evolution of the Brazilian banking and financial systems, the financing at medium-term and long-term remains rare (Ernst &Young, 2011), which causes a scarcity in credit offer to the firms. This fact coupled with the lack of mature market institutions and the high interest rates charged on loans to private sector, make it difficult to firms operating in sectors that highly depend on bank funding, to get the funds and to expand their activities. All these "institutional voids" linked to the Brazilian financial market represent a barrier not only for small firms, but also for large ones. To illustrate this idea, Embraer, a large Brazilian multinational company, confirms that due to the lack-well developed financial market, the support of Brazilian government was necessary to help her expand its activities to foreign markets (Parente et al, 2013). In addition, since the data are for the year 2010, one can also explain the credit scarcity in the Brazilian financial market, by the effects of the financial crisis of 2008. In the aim of stabilizing the financial market after the crisis, the Brazilian

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<sup>4</sup>See Appendix 3 to have more details about the augmented specifications and the variables' definitions.

<sup>5</sup>Note that the coefficients do not correspond to the real effect of explanatory variables on the dependent variable. Computing Marginal effects is necessary to get the exact changes in the dependent in the export variable after a change in explanatory variable. Having said that, the signs and the significance of the coefficients of these regressions do not change, in comparison with those of marginal effects.

authorities imposed capital inflows controls. Alfaro et al (2014) examined the effects of these controls on Brazilian firms. Their findings suggest a drop in the advantages of being a large firm in accessing to credit and that firms external finance dependent firms suffered more from the imposition of these controls. The negative effect of the crisis on the access to credit was also demonstrated for the industries of the Euro zone. Particularly, sectors that are more dependent on external finance have seen their access to credit harder (The Quarterly report on the Euro Area, 2013).

**Table 1:** Effect of financial constraints on firm exports within sectors - Brazilian sectoral External Finance Dependence Indicator -Interval Regression

Dep. Var: Export Intervals	(1)	(2)	(3)	(4)	(5)	(6)	(7)
$L_f$	1.707***	1.709***	1.461***	2.773***	2.771***	2.537***	2.535***
$EFD_s \times L_f$	-0.107**	-0.096**	-0.068*	-0.047	-0.036	-0.023	-0.011*
Exp2009			2.264***			2.112***	2.118***
Parent				-2.968***	-2.960***	-2.907***	-2.897***
South		-0.003	-0.004		0.053		0.053
North		0.086	0.269		0.268		0.430**
NorthEast		0.818***	0.785***		0.636***		0.604***
CentralWest		0.522**	0.665***		0.016		0.175
_cons	12.437***	12.386***	10.505***	14.184***	14.149***	12.381***	12.332***
Controls:				Sector F.E.			
lnsigma_cons	0.939***	0.935***	0.906***	0.827***	0.825***	0.796***	0.794***
Log Likelihood	-7966.036	-7947.370	-7717.772	-7305.978	-7293.141	-7089.306	-7075.426
#observations	10266	10262	10262	10266	10262	10266	10262

Reference firm: Small or medium-sized company, CNAE 21, in the Southeast of Brazil.

Sector controls are not reported. Significance: \* 1%, \*\* 5%, \*\*\* 10%

I move then to discuss the results obtained from augmented specifications. Region dummies do not affect the sign and the significance of my variable of interest. Compared to Southeast region, operating in the region of the Northeast has a positive effect on the export performance of Brazilian firms. Although South and Southeast regions are more branched (Kumar and Francisco, 2005), this result can be justified by the tax and other investment incentives offered by the Brazilian government in order to promote activities in this region (Ernst &Young, 2011). I also introduce a dummy variable Exp2009 that indicates whether the firm exported in 2009 or not; this variable can account for the extensive margin of trade. Similarly, I find that being an exporter in 2009 has a positive effect on the export performance in 2010. In fact, being an exporter in 2009 means that in 2010, the firm has to pay only variable costs, since up-front costs are supposed to be paid in 2009 or before, in line with the context of Manova (2013). As a consequence, the firm can be less constrained in 2010 which makes it more possible for her to export higher values in 2010, *ceteris paribus*. Unlike region and Exp2009 dummies, the inclusion of Parent as a variable of control affects the significance of

the interaction between the size and the level of dependence on external finance for Brazilian industries. The non-significance of this variable of interest may tell the reader that the credit constraints encountered by exporting firms are likely to be driven by the firm structure rather than the level of financial vulnerability in which the firm acts. The estimation results show that a firm exports more when it is an affiliate firm of a parent company established in Brazil. Export activity is driven by subsidiaries and branches of Brazilian and Multinational companies. Due to data availability, I cannot properly make the difference between subsidiaries of foreign companies (headquarters abroad) and of Brazilian owned companies (headquarters in Brazil). I can, however, present some explanations for the fact that affiliated firms export rather than the main establishments in Brazil. It is mainly related to federal incentive programs designated to promote the growth of Brazilian exports. A firm which decides to create a branch for export production benefits from government support (UHY Report, 2013). In this way, companies established in Brazil and aiming to export may see it profitable to create branches or subsidiaries devoted to export activities, in order to benefit from tax and investment advantages. Another argument relative to the Brazilian case may be the related to the market size of Brazil. In order to meet the demand in different regions of Brazil, a company may see it less costly to establish a subsidiary near the customers in the different regions of Brazil, rather than paying high transport and delivery costs (ABP Offshore, 2014). According to Brazilian National Logistics and Transport Plan (PNLT) established in 2007, a number of investments are needed to better the transport infrastructure and logistics sector, notably the extension of the interconnections of the North-South regions. Taking into account these different facts, assume that an exporting company, established in São Paulo, wants to sell a part of her goods in Manaus. Here, if the firm decides to create a subsidiary in Manaus, it will benefit not only from government incentives related to its exporting activities but also from tax incentives for developing the region of Amazonas, notably those offered by the Superintency for the Development of the Amazon (SUDAM).

**Table 2:** Effect of financial constraints on firm exports within sectors - Brazilian level of sectorial Asset Tangibility -Interval Regression

Dep. Var:	(1)	(2)	(3)	(4)	(5)	(6)	(7)
Export Intervals							
$L_f$	2.940***	2.890***	2.488***	3.280***	3.232***	2.935***	2.876***
$Tang_s \times L_f$	-3.388***	-3.259***	-2.861***	-1.406***	-1.293**	-1.132**	-0.989*
Exp2009			2.257***			2.110***	2.115***
Parent				-2.952***	-2.944***	-2.893***	-2.884***
South		-0.004	-0.001		0.056		0.053
North		0.045	0.229		0.252		0.414***
NorthEast		0.807***	0.772***		0.631***		0.597***
CentralWest		0.496**	0.638***		0.007		0.167
_cons	12.047***	12.020***	10.206***	14.004***	13.993***	12.253***	12.233***
Controls:				Sector F.E.			
lnsigma_cons	0.938***	0.934***	0.905***	0.827***	0.825***	0.796***	0.794***
Log Likelihood	-7951.955	-7933.888	-7706.296	-7303.166	-7290.576	-7087.101	-7073.649
#observations	10266	10262	10262	10266	10262	10266	10262

Reference firm: Small or medium-sized company, CNAE 21, in the Southeast of Brazil.

Sector controls are not reported. Significance: \* 1%, \*\* 5%, \*\*\* 10%

I move then to the second proxy of financial vulnerability for Brazilian industries which is the ratio of asset tangibility. In line with the literature, Table 2 shows that large firms export more than small and medium ones and that this effect is less pronounced in sectors that with high part of tangible assets in total assets. Firms operating in these sectors may have easier access to bank credit than those in sectors with more intangible assets such as pharmaceutical industry. Tangible assets can be presented as collaterals when demanding external funding. Consequently, having more tangible assets is considered as a form of relaxation of credit constraints. This may reduce the importance of firm size on accessing to external finance. Finally, I estimate the same specifications using an Ordered Probit probability model. This model has as its ordered dependent variable levels of export performance for Brazilian exporting firms during the year 2010. The estimation results in Appendix 4 are similar to those of interval regressions<sup>6</sup>. The results show that large firms have greater probability to export more than 100 million US \$ and that this probability is less important when the firm acts in a sector with higher external financial needs. The augmented specifications explain more precisely the export performance of Brazilian exporting firms since the pseudo- $R^2$  are higher when the control variables are included.

<sup>6</sup>To make comparison between interval regression results and ordered probit ones, the coefficients in Interval regression models should be divided by the value of  $\sigma$ .

## 8 Robustness checks

In this paragraph, I examine whether the measure of external finance dependence used to proxy the level of financial vulnerability of industries matters. In the previous section, I focus on Brazilian measures which I calculated over the recent period 2000-2012. Here, I conduct a number of tests to ensure the robustness of my results. To do that, I use different proxies of external finance dependence that have been employed in the empirical literature. These measures are based on data for US firms and are computed over earlier periods notably the 80s and the 90s. The first important measure of sectorial reliance on outside financing is the Rajan and Zingales (1998) measure. This measure is originally computed for the 80s and was updated for the 90s by Kroszner et al (2007). Other measures claimed to be accounting for the financial external dependence at industry-level include the R&D intensity and the share of tangible assets in the total assets. Table 3 presents the estimation results using Interval regressions for the basic specification. Practically, all the variables in the model present the same signs as when the external finance dependence is proxied by Brazilian specific indicators. The tests show that large companies have higher export performances compared to small and medium firms, and that this positive effect of being large affects less the export performances when the firm operates in a sector which highly relies on external capital. The results remain robust to the inclusion of the variables of control (see **Table 4**)<sup>7</sup>.

**Table 3:** Robustness Checks - Basic specification

Dep. Var :	EFD	EFD	R&D	Asset
Export levels	US 80s	US 90s	Intensity	Tangibility
$L_f$	1.770***	1.742***	1.822***	3.385***
$FinVuln_s \times L_f$	-0.034	-0.458***	-2.047**	-5.600***
_cons	12.355***	12.834***	12.831***	12.006***
Controls:	Sector F.E.			
Insigma_cons	0.928***	0.926***	0.927***	0.925***
Log Likelihood	-7908.191	-7904.252	-7905.777	-7879.151
#observations	10266	10266	10266	10266

Reference firm: Small or medium-sized company, CNAE 21.

Sector controls are not reported. Significance: \* 1%, \*\* 5%, \*\*\* 10%

The only exception is related to the interaction term between the size dummy and the sectorial measure of external finance dependence of Rajan and Zingales (1998) computed over the 80s, which appears statistically insignificant. This finding reinforces the pertinence of computing industry-level measures of external finance dependence specific to Brazil, and built using data on recent periods. Due to the gap in terms of economic and financial development between the Brazilian economy and the US one, the level of dependence on external

<sup>7</sup>I do not report the results of all the augmented specifications. The results remain globally unchanged when including the different variables of control and robust to both methods of estimation.

capital may differ for one sector across countries. A notable example is the Plastics industry, which was very reliant on external funding in the US in the 1980s and much less dependent in Brazil in the recent years. The Brazilian government has launched a program for accelerating the growth (Programa de Aceleração do Crescimento) in 2007 aiming at promoting the whole economy but seems to have particular positive effects on Plastic sector (Society of Plastics Engineers Magazine, 2014). Furthermore, the Plastic industry benefits since 2004 from government support in the form of The Export Plastics Program implemented by APEX-Brazil, the Brazilian Trade and Investment Promotion Agency. These different programs provide this industry with funds, from different sources, which may help her be less credit constrained. Finally, the results show that large firms export more in sectors with more tangible assets, which is consistent with the findings of the previous section and in line with the predicted effects in the literature. In order to exploit the differences in terms of firm size, I have also distinguished between large and very large firms. The results remain unchanged. As presented in Appendix 5, very large firms exhibit better export performances than large firms and small and medium-sized ones and that they benefit less from their size advantage when they operate in sectors with higher external funding needs<sup>8</sup>.

**Table 4:** Robustness Checks - Augmented specification

Dep. Var:	EFD	EFD	R&D	Asset
Export levels	US 80s	US 90s	Intensity	Tangibility
$L_f$	1.488***	1.470***	1.552***	2.927***
Exp09	2.274***	2.268***	2.274***	2.258***
FinVuln <sub>s</sub> xL <sub>f</sub>	-0.014	-0.403**	-2.160**	-4.959***
South	-0.005	-0.007	-0.006	-0.010
North	0.252	0.267	0.258	0.213
NorthEast	0.716***	0.710***	0.716***	0.689***
CentralWest	0.638***	0.657***	0.659***	0.618***
_cons	10.453***	10.897***	10.973***	10.163***
Controls:		Sector F.E.		
lnsigma_cons	0.984***	0.893***	0.893***	0.892***
Log Likelihood	-7656.698	-7653.495	-7653.880	-7632.937
#observations	10262	10262	10262	10262

Reference firm: Small or medium-sized company, CNAE 21, in the Southeast of Brazil.

Sector controls are not reported. Significance: \* 1%, \*\* 5%, \*\*\* 10%

## 9 Conclusion

In this paper, I investigate the impact of the financial frictions on the export performances in Brazil. I provide micro-level evidence on the role of industry constraints coupled with

<sup>8</sup>I also perform further regressions where I distinguish between small, medium, large and very large firms. The estimation results show that the firm size may present a slight inflection for medium firms. However, this may be due to dispersion issues. These results are not reported.

the firms' characteristics in the access to credit and in consequence, in the firms' ability to perform when entering foreign markets. Using data from the Brazilian customs for the year 2010, I show that the firm size has a positive effect on the firms' performances, notably, the firms' export participation. Large firms are found to be more likely to be export performant compared with small and medium firms. However, the importance of the firm size decreases when the exporting firm operates in an industry that highly relies on external funding, to finance her investments. Although this result is not in line with the literature's predictions, it can be consistent relative to the Brazilian context. The level of development of the Brazilian financial system makes the cost of external finance high. Since large Brazilian firms are in their majority family-owned compared to those in other countries where they are mainly multinational companies (Brainard and Martinez-Diaz, 2009), their access to external finance may not be as easy as one can suggests. In addition, the recent Brazilian action through SME financing programs could be behind the disturbances in terms of productivity and efficiency, in comparison with the standard link between firms size, productivity level and export performances as considered by the standard heterogeneous firms trade models. Moreover, note that the analysis concerns the year 2010, soon after the global financial crisis. This fact may alter the results since the credit scarcity in Brazil, as in all over the world, has been reinforced. Large companies were not immunized against the lack of funds. Other firms' characteristics are found to affect the export performances. Being an exporter in 2009, for example, is a factor in favor of exporting more in 2010. This is in line with the predictions of Manova (2013), since these firms will not need to pay fixed costs related to export activity, in 2010. Being a subsidiary and not a main establishment in Brazil is also in favor of higher export performances. Relatively to this point, it would be interesting to distinguish between Brazilian companies and Foreign-owned companies, in future researches. In fact, it is assumed that foreign-owned firms (multinational or joint-venture) have less credit constraints since they can seek for external finance, internationally (Manova et al, 2011).

With regards to the importance of firm size as a determinant in being a performant exporter, I recognize that being large may be endogenous in the regression on export performance intervals. For example, the learning-by-exporting effects suggest that, a part from the positive effect of size on the probability of exporting, exporting companies have more chances to be productive and to expand and become large (Araújo, 2005; Araújo and Pianto, 2010). Due to lack of data, treating this endogeneity issue was not possible.

An implicit implication of the results is that the firm size can have mitigated effects on firm's performances, particularly in countries with underdeveloped financial systems. In order to better the Brazilian performances in terms of international trade, an action may be required to relax credit constraints not only for SME, but also for large firms. The findings of this paper must be interpreted relatively to the current context of the international scene, after the global crisis of 2008. In fact, the effects of the financial crisis have resulted in a range

of financial and economic reforms and controls (as in Brazil) that made the access to credit worse, which in return negatively affects firms' investments and the economic prosperity, as well. Policy implication for limiting the effects of the financial crisis would matter. It follows that further research is needed to disentangle the effects of the financial crisis from the effects of the country's and sector's financial frictions, when explaining the firms' export performances.

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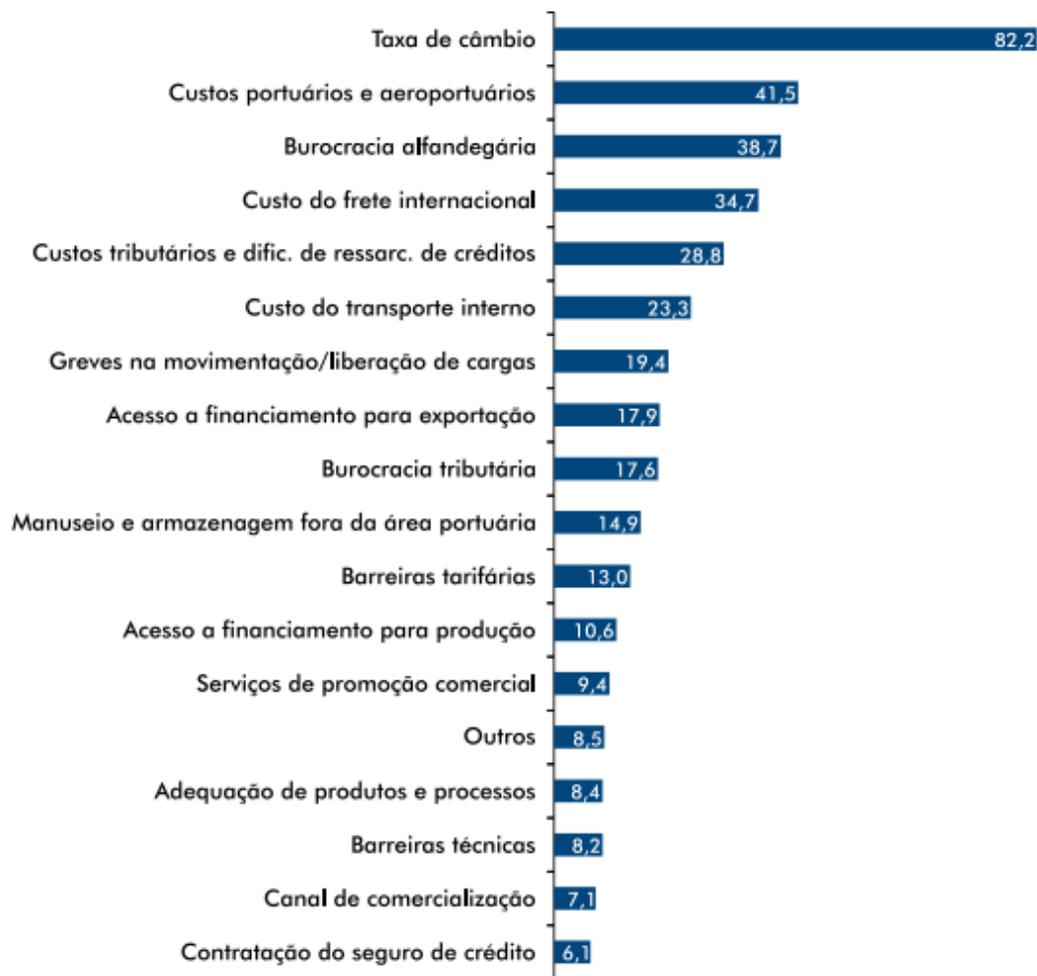
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## 11 Appendix

### Appendix 1: Constraints to Brazilian exports\*



Source: Pesquisa Os problemas da empresa exportadora brasileira, CNI, 2008. \* in % of the total number of firms that encounter constraints to expand their export activities.

**Appendix 2: External Finance Dependence -Manufacturing Sectors In Brazil**

CNAE	Industrial Sectors	External Finance pendence	Tangibility De-
2.0			
30	Other transport equipment	-6,94	0,11
15	Leather and related products	-6,60	0,12
12	Tobacco	-6,54	0,20
11	Beverages	-3,66	0,19
26	Computer, electronic and optical products	-3,20	0,03
22	Rubber and plastic products	-1,91	0,46
31	Furniture	-1,41	0,28
18	Printing and reproduction of recorded media	-0,91	0,32
24	Metallurgy	-0,76	0,44
23	Non-metallic mineral products	-0,67	0,37
27	Electrical equipment	-0,41	0,25
20	Chemicals	-0,17	0,42
13	Textiles	-0,12	0,42
25	Fabricated metal products, except machinery and equipment	-0,11	0,33
17	Paper and paper products	-0,09	0,58
29	Motor vehicles, trailers and semi-trailers	-0,08	0,36
16	Wood products	-0,06	0,62
14	Wearing Apparel	-0,04	0,39
19	Coke and refined petroleum products	0,03	0,37
28	Machinery and equipment n.e.c	0,26	0,25
32	Other manufacturing	0,32	0,16
10	Food Products	0,37	0,39
21	Pharmaceutical products	1,99	0,17

### Appendix 3: Descriptive Statistics

Table 3a: Exports and Firm Size

Class of exports (millions US \$)	Size				Total
	S	M	L	VL	
< 1	2580	3423	1166	118	7287
1-10	680	451	729	116	1976
10-50	337	27	188	138	690
50-100	83	0	23	42	148
> 100	106	1	5	53	165
Total	3,786	3,902	2,111	467	10266

Table 3b: Sector financial dependence by firm size

Size category	Level of by EFD			
	Low	Medium	High	Total
S	1007	1955	824	3786
M	1036	2310	556	3902
L	657	1201	253	2111
VL	110	241	116	467
Total	2810	5707	1749	10266

Large	Level of by EFD			
	Low	Medium	High	Total
0	2043	4265	1380	7688
1	767	1442	369	2578
Total	2810	5707	1749	10266

Table 3c: Extensive Margin of Trade

Class	Exp2009		Total
	0	1	
< 1	1,831	5,456	7,287
1-10	104	1,872	1,976
10-50	35	655	690
50-100	4	144	148
> 100	8	157	165
Total	1,982	8,284	10,266

### Appendix 4: Ordered Probit Model

I apply an Ordered Probit specification in order to deal with my dependent variable which is a categorical variable: *Class of Exports<sub>j</sub>*. I am interested in the study of the probability of being in a given *Class of Exports<sub>j</sub>*. I recall the specification:

$$P(\text{Class of Exports}_j | \text{Observed variables})_f = \beta_0 + \beta_1 \cdot L_f + \beta_2 \cdot \text{FinVul}_s \times L_f + \varphi_s + \varepsilon_{fs}$$

The probability for an exporting firm to export in a given *Class of Exports<sub>j</sub>* can be defined as follows:

$$\text{Prob}(\text{Class of Exports}_1=1 | X) = \Phi(\mu_1 - X' \beta)$$

$$\text{Prob}(\text{Class of Exports}_2=2 | X) = \Phi(\mu_2 - X' \beta) - \Phi(\mu_1 - X' \beta)$$

$$\text{Prob}(\text{Class of Exports}_3=3|X) = \Phi(\mu_3 - X'\beta) - \Phi(\mu_2 - X'\beta)$$

$$\text{Prob}(\text{Class of Exports}_4=4|X) = \Phi(\mu_4 - X'\beta) - \Phi(\mu_3 - X'\beta)$$

$$\text{Prob}(\text{Class of Exports}_5=5|X) = 1 - \Phi(\mu_4 - X'\beta)$$

Where  $\Phi(c)$  is the cumulative distribution function of the error  $\varepsilon$  and  $X$  is the vector of explanatory variables defined above.

The estimation of  $\beta$  parameters is driven by maximum likelihood estimation. I note  $y_j = \text{Class of Exports}_j$ . Then, the likelihood function is defined:

$L = \text{Pr}(y_1 = 1 ; y_2 = 1 ; \dots ; y_{N_1} = 1 ; y_{N_1+1} = 2 ; \dots ; y_{N_2} = 2 ; y_{N_2+1} = 3 ; \dots ; y_{N_3} = 3 ; y_{N_3+1} = 4 ; \dots ; y_{N_4} = 4 ; y_{N_4+1} = 5 ; \dots ; y_N = 5)$  with  $N$  the total number of observations for Brazilian exporters in 2010.

$$\begin{aligned} L &= \prod_{i=1}^{N_1} \text{Pr}(y_j=1) \times \prod_{i=N_1+1}^{N_2} \text{Pr}(y_j=2) \times \prod_{i=N_2+1}^{N_3} \text{Pr}(y_j=3) \times \prod_{i=N_3+1}^{N_4} \text{Pr}(y_j=4) \times \prod_{i=N_4+1}^N \text{Pr}(y_j=5) \\ L &= \prod_{i=1}^{N_1} \Phi(\mu_1 - X'\beta) \times \prod_{i=N_1+1}^{N_2} [\Phi(\mu_2 - X'\beta) - \Phi(\mu_1 - X'\beta)] \times \prod_{i=N_2+1}^{N_3} [\Phi(\mu_3 - X'\beta) - \Phi(\mu_2 - X'\beta)] \\ &\times \prod_{i=N_3+1}^{N_4} [\Phi(\mu_4 - X'\beta) - \Phi(\mu_3 - X'\beta)] \times \prod_{i=N_4+1}^N [1 - \Phi(\mu_4 - X'\beta)] \end{aligned}$$

Thus, the log likelihood function is:

$$\begin{aligned} \ln L &= \sum_{i=1}^{N_1} \ln F(\mu_1 - X'\beta) + \sum_{i=N_1+1}^{N_2} \ln [\Phi(\mu_2 - X'\beta) - \Phi(\mu_1 - X'\beta)] \\ &+ \sum_{i=N_2+1}^{N_3} \ln [\Phi(\mu_3 - X'\beta) - \Phi(\mu_2 - X'\beta)] + \sum_{i=N_3+1}^{N_4} \ln [\Phi(\mu_4 - X'\beta) - \Phi(\mu_3 - X'\beta)] \\ &+ \sum_{i=N_4+1}^N \ln [1 - \Phi(\mu_4 - X'\beta)] \end{aligned}$$

Table 4a: Effect of financial constraints on firm exports within sectors - Brazilian External  
Finance Dependence Indicator -Ordered Probit

Dep. var: Export levels	(1)	(2)	(3)	(4)	(5)	(6)	(7)
Large	0.665***	0.668***	0.588***	1.210***	1.211***	1.142***	1.143***
EFD <sub>s</sub> xLarge	-0.042**	-0.038**	-0.028*	-0.021	-0.016	-0.011	-0.005
Exp2009			0.914***			0.952***	0.957***
Parent				-1.297***	-1.296***	-1.310***	-1.308***
South		-0.001	-0.002		0.023		0.023
North		0.034	0.108		0.117		0.194
NorthEast		0.321***	0.317***		0.279***		0.273***
CentralWest		0.206**	0.270**		0.008		0.080
Controls:				Sector F.E.			
cut1_cons	0.541***	0.564***	1.340**	-0.158	-0.143	0.649***	0.673***
cut2_cons	1.413***	1.439***	2.244***	0.821***	0.839***	1.663***	1.689***
cut3_cons	2.086***	2.115***	2.935***	1.567***	1.586***	2.426***	2.254***
cut4_cons	2.388***	2.417***	3.243***	1.895***	1.915***	2.760***	2.788***
Log Likelihood	-7962.431	-7943.690	-7714.800	-7303.436	-7290.583	-7087.398	-7073.497
Pseudo R <sup>2</sup>	0.1079	0.1097	0.1354	0.1817	0.1829	0.2059	0.2073
observations	10266	10262	10262	10266	10262	10266	10262

Reference firm: Small or medium-sized company, CNAE 21, in the Southeast of Brazil.

Sector controls are not reported. Significance: \* 1%, \*\* 5%, \*\*\* 10%

Table 4b : Effect of financial constraints on firm exports within sectors - Brazilian level of sectoral Asset Tangibility -Ordered Probit

Dep. var: Export levels	(1)	(2)	(3)	(4)	(5)	(6)	(7)
Large	1.148***	1.133***	1.004***	1.432***	1.414***	1.321***	1.298***
EFD <sub>s</sub> xLarge	-1.326***	-1.280***	-1.157***	-0.616***	-0.568**	-0.511**	-0.448*
Exp2009			0.912***			0.951***	0.955***
Parent				-1.290***	-1.289***	-1.303***	-1.302***
South		-0.001	-0.001		0.024		0.024
North		0.018	0.093		0.110		0.187**
NorthEast		0.317***	0.312***		0.277***		0.270***
CentralWest		0.196**	0.259***		0.004		0.076
Controls:	Sector F.E.						
cut1_cons	0.695***	0.708***	1.462**	-0.079	-0.074	0.707***	0.718***
cut2_cons	1.568***	1.584***	2.367***	0.900***	0.908***	1.721***	1.734***
cut3_cons	2.241***	2.260***	2.059***	1.646***	1.655***	2.484***	2.499***
cut4_cons	2.543***	2.563***	3.367***	1.974***	1.984***	2.818***	2.834***
Log Likelihood	-7948.395	-7930.256	-7703.355	-7300.638	-7288.028	-7085.196	-7071.718
Pseudo R <sup>2</sup>	0.1095	0.1112	0.1367	0.1820	0.1832	0.2062	0.2075
observations	10266	10262	10262	10266	10262	10266	10262

Reference firm: Small or medium-sized company, CNAE 21, in the Southeast of Brazil.

Sector controls are not reported. Significance: \* 1%, \*\* 5%, \*\*\* 10%

**Appendix 5:** Regressions with disaggregated size dummies

I estimate the following equation, using Interval regression :

$$\ln Exports_f = \beta_0 + \beta_1 \cdot L_f + \beta_2 \cdot VL_f + \beta_3 \cdot FinVul_s \times L_f + \beta_4 \cdot FinVul_s \times VL_f + \varphi_s + \varepsilon$$

Table 5a : Effect of financial constraints on firm exports within sector- Disaggregated size dummies

Dep Var:	EFD	Asset Tang
Export Intervals		
$L_f$	2.063***	2.446***
$VL_f$	4.175***	4.563***
$FinVul_s \times L_f$	-0.114**	-3.216***
$FinVul_s \times VL_f$	-0.139*	-3.737***
_cons	12.471***	12.066***
Conrols:	Sector F.E	Sector F.E
lnsigma_cons	0.909***	0.908***
Log likelihood	-7870.241	-7857.077
observations	10266	10266