

DOCUMENT DE TRAVAIL

DT/2016-18

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Fatma BOUATTOUR

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Place du Maréchal de Lattre de Tassigny 75775 • Paris • Tél. (33) 01 44 05 45 42 • Fax (33) 01 44 05 45 45
• 4, rue d'Enghien • 75010 Paris • Tél. (33) 01 53 24 14 50 • Fax (33) 01 53 24 14 51
E-mail : dial@dial.prd.fr • Site : www.dial.ird

Financial Constraints and Export Performances: Evidence from Brazilian Micro-Data

Fatma Bouattour*

*(1) PSL, University of Paris-Dauphine, LEDa, DIAL UMR 225, F-75016 Paris, France, (2) IRD, LEDa, DIAL UMR 225, F-75010 Paris, France; e-mail: fatma.bouattour@dauphine.fr. I am grateful to Pr. Jean-Marc Siroën (DIAL) and to Pr. Marta Dos Reis Castilho (Federal University of Rio de Janeiro, UFRJ) for their support and guidance.

Abstract

This paper explores the effects of financial constraints on export performances of Brazilian exporters in 2010. Specifically, I revisit the role of firm size as a predictor of firm-level financial constraints and take into account the sector-level financial constraints. In order to capture the specificities of the Brazilian market, I use sector-level measures of dependence on external finance computed over Brazilian data and following the method of Rajan and Zingales (1998, RZ). Since Brazilian export data are presented in ranges of value, I estimate an interval regression model (Conroy, 2005). The results confirm that larger firms have better export performance, and that the size advantage is reduced in Brazilian sectors that depend on external finance/ have better access to finance. These findings remain robust when I control for the regional heterogeneity in Brazil and the legal status of the exporting firms. I then consider the sector-level heterogeneity in terms of inherent needs of external finance by using RZ indicators. The results show that large firms are less export performant in sectors that are by nature more dependent on external finance. This result can be explained by the imperfections that characterize the Brazilian financial market.

Keywords: Firm size, Sector-level external finance dependence, Financial market imperfections, Exports, Brazil, Interval Regression

JEL Classification: F10, F12, F14, G30, G32, L25

Résumé

Ce papier étudie les effets des contraintes de financement sur les exportations des firmes exportatrices brésiliennes en 2010. Il s'agit particulièrement de revisiter le rôle de la taille de la firme en tant qu'indicateur des contraintes financières au niveau-firme, tout en prenant en considération les différences intersectorielles en termes de besoins de financements externes. Afin de mettre en avant les spécificités du marché financier brésilien, nous utilisons des mesures sectorielles de dépendance à la finance externe construites suivant la méthodologie de Rajan et Zingales (1998, RZ), et en se basant sur des données brésiliennes. Les données douanières sur les exportations de firmes brésiliennes étant sur intervalles, la méthode d'estimation utilisée est donc la régression par intervalle (Conroy, 2005). Les résultats confirment l'effet positif de la taille, comme mesure de la facilité d'accès au crédit, sur les exportations des firmes brésiliennes. L'avantage lié à la taille baisse cependant dans les secteurs qui ont une dépendance de la finance externe au Brésil et donc un accès favorisé au crédit. Ces résultats restent robustes lorsque nous considérons l'hétérogénéité régionale au Brésil et les différences dans le statut légal des firmes. En considérant les indicateurs de RZ comme reflétant les différences technologiques entre les secteurs, les résultats montrent que l'avantage lié à la taille de la firme joue moins dans les secteurs qui sont de par leur nature dépendants de la finance externe. Ce résultat peut être justifié par les imperfections du marché financier brésilien.

Mots-clés: Taille des firmes, Mesures sectorielles de dépendance à la finance externe, Imperfections du marché financier, Exportations, Brésil, Regression par intervalles

Classification JEL: F10, F12, F14, G30, G32, L25

1 Introduction

Even with the growing role of Brazil as a global trader, it is widely recognized that export challenges persist. Gusso et al (2004) argue that the effects of export promotion policies, implemented in the 1990s, on exports did rarely last. Moreover, the appreciation of the currency is generally considered as a major factor that hampers Brazilian exporters. Compared to other emerging markets, Brazil has witnessed an important appreciation of the effective real exchange rate over the last decade, which translated into high export prices. A part from this factor, problems in access to finance also seem to impede Brazilian exporters' performances. Despite Brazilian reforms to restructure the financial system, financial intermediation in Brazil continues to lack efficiency. Precisely, Brazil falls behind other emerging and developed countries in terms of availability of private credit and liquid liabilities, and in terms of legal framework quality, as well (Beck et al, 2000). The underdevelopment of Brazilian financial system is particularly attributed to high inflation and real interest rates, resulting in a high cost of capital (Bittencourt, 2011). Besides, it seems that Brazilian government policies to reduce financing problems do not usually succeed. For instance, the efficiency of subsidized credit provided by the Brazilian Bank of Development BNDES remains a source of debate (Oliveira, 2014; Lazzarini et al, 2015). These factors result therefore in distortions in the allocation of capital between firms and between sectors, as well.

As argued in the literature, financial frictions affect firms' investments. Considering the exporting activity as a form of investment (Melitz, 2003), the aim of this paper is to analyze the effects of financing constraints on Brazilian export performances. While the literature on Brazilian trade focuses on the effects of exchange rates (Bahmani-Oskooee et al, 2013; Chatterjee et al, 2013), this paper is one of the first works to be interested in the role of financing problems in explaining Brazilian trade.

As confirmed in the literature, the financial health of firms affects their investments (Aghion et al, 2010). In this regard, Bond et al (2007) argue that Brazilian firms are more likely to be credit constrained compared with Chinese ones. Moreover, a survey of Brazil's National Confederation of Industry (CNI) shows that large exporters do face constraints when dealing with their export activity. Based on these ideas, the present study analyzes Brazilian firm-level financial constraints by revisiting the role of firm size in export performances.

The literature on the determinants of international trade is marked by a growing interest in the role of finance and financing constraints. It has been particularly demonstrated that the financial underdevelopment in exporting countries impede export performances. Compared with domestic sellers, exporters are in a higher need for liquidity. This is particularly due to the additional fixed costs to be paid up-front when entering foreign markets and to the time gap between the production and the payment. The introduction of these financial constraints, in standard international trade models with heterogeneous firms (Melitz, 2003) leads the productivity cut-offs to be more restrictive, particularly in sectors with high external capital requirements (Manova, 2008; 2013; Rajan and Zingales, 1998). In other words, firms should be

more productive in order to remain profitable when entering the export market. In line with this context, a large empirical literature studying the peculiar characteristics of exporting firms has emerged. Firm size is generally considered to be associated with productivity, survival and profitability (Beck et al, 2005). Considering that, the positive link between firm size and export performances would be obvious (Calof, 1998; Williams, 2011). It is however not clear if in presence of financial weaknesses, large firms would perform better than smaller ones. On the one hand, large firms are assumed to have better performances which may make them less constrained (Beck et al, 2005). On the other hand, large firms are more likely to rely on external finance, and in this case, the underdevelopment of financial institutions would disproportionately hurt large firms. This paper attempts to provide an answer to this debate on the importance of firm size in a context of imperfect financial markets.

To summarize, this paper adds to the growing literature on the importance of financial frictions in explaining trade performances. Precisely, this paper considers the theoretical framework of Manova (2008; 2013) as reference, and analyzes the financial determinants of export performances of Brazilian exporters in 2010. This paper provides four main contributions. First, this paper is interested in the study of the Brazilian case. The gap between the Brazilian potential in terms of integration in the international market and the actual performances is puzzling. While the Brazilian economy was assumed to be one of the top economies, the performances during the last decades made some economists, such as Jim O’Neill (former Goldman Sachs economist), doubt about the legitimacy of Brazil’s place in the BRICS group of emerging economies. As detailed before, the financial conditions in Brazil do not seem favorable to expanding investment activities, despite the efforts of Brazilian authorities to relax credit constraints over the last decades. Taking into account these Brazilian characteristics, I compute measures of sector financial vulnerability¹ *specific* to the Brazilian manufacturing industries. These indexes are an adaptation of Rajan and Zingales’ (1998, henceforth RZ) indicators of dependence on external finance, assumed to reflect sectors’ differences in terms of external finance needs driven by their *technological* differences. Unlike RZ indicators, Brazilian measures presented in this paper would reflect the intersectoral differences in terms of external financing needs, taking into account the Brazilian context. In this way, the effects of the underdeveloped Brazilian financial sector would be reflected in the intersectoral heterogeneity in terms of needs of finance. This may lead the analysis to be subject to an endogeneity problem. In order to address this issue, I also make use of the original RZ indicators based on US data. The second contribution of this paper is to exploit firm-level data. Studies on the effects of credit constraints on exports at firm-level are rare, due to the difficulty of obtaining detailed firm data. In this regard, only data on *export ranges* are made available to the public, by the Brazilian customs service SECEX. This leads the econometric method to be based on Interval Regression (Conroy, 2005). Since this method is not commonly used in the field of international trade, the third contribution of this paper would be to use this method

¹By financial vulnerability, I refer to the need for external capital, i.e. the requirements in terms of funds provided by the financial and banking sector.

of estimation that copes with censored data. Finally, this paper revisits the link between firm size and export performances. In a framework à la Melitz, firm size would be a proxy of firm productivity. In a context of imperfect financial markets however, the relation between firm size and firm-productivity would be altered. Therefore, in this paper, firm size will be rather considered as a measure of firm-level financial constraints.

In this paper, I refer to export behavior in terms of export intensity, i.e. the intensive margin of trade². I consider an exhaustive sample of Brazilian exporters in manufacturing industries in 2010. The choice of 2010 is motivated by the relatively fast recovery of emerging markets, after the financial crisis of 2008. Data on firm exports are provided by the SECEX. Data on firm size are mainly obtained from the Annual List of Social Information (Relação Anual de Informações Sociais, RAIS), a database of the Brazilian Ministry of Labor and Employment. In order to capture the sector-level financial vulnerability, I use Brazilian measures computed over the 2000s, using Brazilian data. These measures express the effects of the underdevelopment of Brazilian financial system on the intersectoral differences in terms of reliance on external capital. Therefore, they are likely to describe the *ease of access* to finance, rather than the needs of external finance. I also make use of US indicators which have been proposed by RZ and widely used in the literature. These measures would rather reflect the *inherent* needs of finance, i.e. those based on technological differences.

Using Interval Regression estimation method, the main findings of this paper confirm the importance of firm size as a predictor of export performances for Brazilian firms, and suggest that the advantage related to firm size loses of its importance when firms operate in sectors that depend more on external finance according to the Brazilian context. This result can be explained by the fact that when accounting for the Brazilian market imperfections, Brazilian indicators measure the ease of *access* to finance. Therefore, one can defend the fact that the advantage of large firms decreases in sectors that can easily get external finance in Brazil. These findings remain globally robust to the control of firms' legal status and the Brazilian regions' heterogeneity in terms of economic and financial development. The results remain globally unchanged. The firm size advantage in terms of export performances is also found to be reduced when considering the intersectoral differences in terms of *inherent* needs of external capital. This result sheds the light on the problems in credit availability in Brazil, that would hurt firms operating in sectors that highly rely on external finance. Additional results show the importance of BNDES loans in boosting firms' exports, which suggests that these public loans can be considered as a source of distortion in the financial market. The effects of the financial crisis of 2008 do however not seem to strongly affect the importance of firm size in explaining export performances. Considering all these elements, the findings of this paper have important policy implications, notably with regards to the development of the Brazilian financial sector.

The remainder of the paper is organized as follows. The next section describes the Brazil-

²In terms of total trade values across different industries and destinations, for one exporting firm.

ian context with a focus on Brazilian exporters' constraints. The third section presents a comprehensive review of literature on the impact of financial frictions on international trade. In Section 4, I present the data. Section 5 presents the empirical analysis frameworks: theoretical background as well as methodological concerns. In Section 6, I properly study the effects of firm size on Brazilian export performances with a focus on Brazilian sectors' *specific* financial characteristics. A number of robustness checks are then presented. Section 7 focuses rather on the manufacturing sectors *inherent* needs of external capital, and explores the effects of the recent financial crisis of 2008. The last section concludes.

2 Zoom on the Brazilian context

Brazil has experienced an industrialization process since the 1950s. This process has begun with an import substitution strategy which boosted the economy's productivity, and permitted to switch from a typical exporting country of primary products to a more diversified economy (Suzigan et al, 2007). This industrialization has been however accompanied with protectionist strategies, in order to enhance the development of domestic industrial structure. Beginning with the Real Plan³ in the early 1990s, Brazil has moved towards a more opened economy, which has resulted in an expansion of Brazilian trade (Figure 1). While imports have benefited from a gradual reduction in tariffs, the expansion of exports was particularly supported by export subsidies.

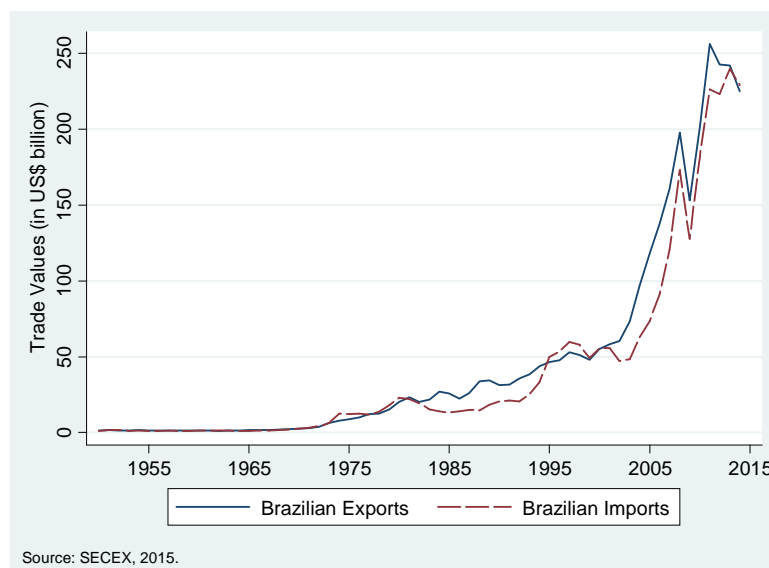


Figure 1: Evolution of Brazilian Trade 1950-2015

At the same time, a number of reforms have been undertaken in order to improve the economy's growth. Brazil has witnessed in this decade of reforms (Baumann, 2001) a wave of privatizations and a restructuring of the financial market. This has resulted in a facilitation of the access to credit and an increase in the inflows of foreign capital. In the 2000s, Brazilian trade continues to grow as it can be shown in Figure 1. This was motivated by a favorable international environment and an increase in Brazil's export prices (Cardoso, 2009).

Focusing on the manufacturing sector, the development of the Brazilian industry has led to a shift of resources towards industrial activities. This can be illustrated by an increase in the share of manufacturing exports, to reach 60% of the total exports in 1993. The importance

³The Real Plan 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 which was partially linked to the US dollar, limited government spending and made other fiscal reforms.

of manufactured goods has been however reduced in the last decade (Figure 2). In 2010, manufacturing goods account only for 39% of the total Brazilian exports. While the Brazilian economy represents the seventh economy in the world, it comes only at the 22th position in terms of exports, and at the 29th position when only considering manufacturing exports (CNI, 2014). It seems that despite the wave of reforms, Brazil does not well exploit its potential of international trade, compared to other BRICS countries (Canuto et al, 2013).

Even if the Brazilian economy is mainly based on the domestic consumption, it is interesting to analyze the barriers behind the low expansion of Brazilian exports. The Brazilian domestic demand accounts only for 4% of the world demand. Expanding exports would then permit to the Brazilian economy to increase its role as a global supplier. According to Bonelli and Pinheiro (2012), the Brazilian economy is facing important competitiveness challenges. Brazil’s National Confederation of Industry (CNI) conducts surveys on a number of Brazilian exporters in order to capture the main problems behind the low performances in terms of international trade. The results of the survey based on data for 2011-2012 are displayed in Figure 3.

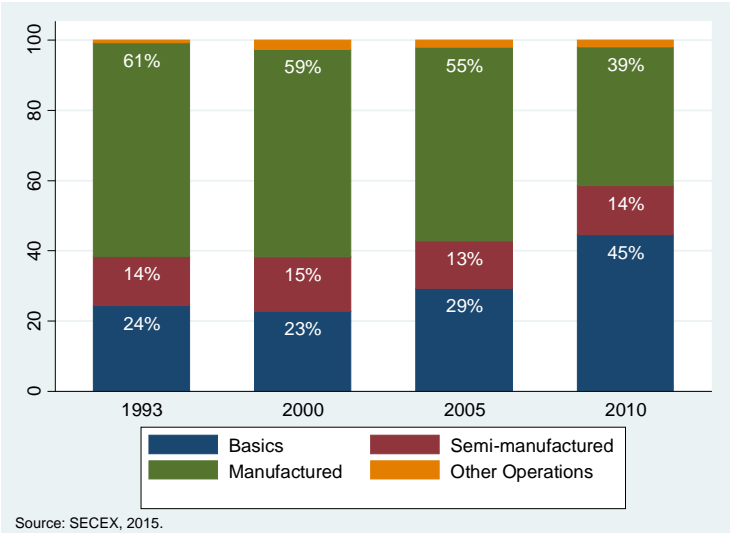


Figure 2: Share of Manufacturing in Brazilian Exports

Unsurprisingly, the appreciation of the Brazilian Real seems to be the main constraint to exports. The results also show that imperfections in the business environment present impediments to export expansion, as suggested by Canuto et al (2013). A part from bureaucracy, problems of financing emerge as an important constraint for exporters. On the one hand, 13% of the respondents consider that financing production activities is an important issue with regards to exporting activity. On the other hand, 16% of exporters in the survey declare having problems in the access to credit lines specific to the exporting activity. These problems of financing could be reflecting the Brazilian context characterized by a high cost

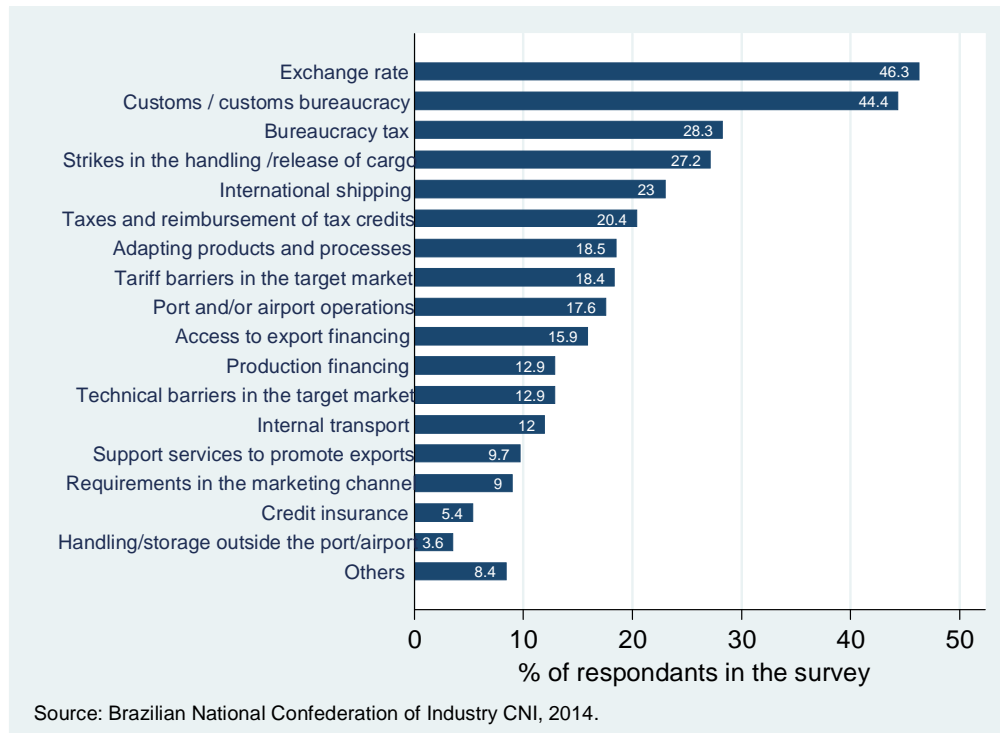


Figure 3: Main Barriers to Brazilian Exporters -2012

of capital and underdeveloped financial institutions. Consistent with this fact, Araujo and Pianto (2010) argue that the novice exporting culture combined with the lack of credit, among other factors, can cause a firm to exit the export market.

Export financing problems are particularly surprising since the Brazilian economy has multiplied the incentives to promote exports, notably financial ones. Among these instruments, one can cite the Project for Export Financing (PROEX). This project is conducted by the Brazilian central bank and aims at providing credit to exporting firms, especially small ones. Moreover, since 1990s, financing exports has been of a major interest for the Brazilian development bank BNDES. This public bank, founded in 1952 to support the development of the Brazilian economy, offers different credit lines at lower interest rates, compared with market rates. In order to promote the industrial activity, the BNDES offers FINAME credit line (Agency for Industrial Financing) which finances the acquisition and the sale of equipment and machines, domestically and internationally. This bank also offers two BNDES-EXIM credit lines specific to the export activity. Pre-shipment lines finance the production of internationally competitive companies, established under Brazilian law, whereas post-shipment credits finance the trade of goods and services abroad by refinancing the Brazilian exporter, or by financing the corresponding importer. Although these different financing tools exist, the access to finance seems to constitute an obstacle when expanding activities to foreign markets. A number of the respondents in the CNI's survey argue that the access to these instruments

is difficult due to the real guarantees required by the financing agencies; this would refer to the importance of tangible assets as collaterals when contracting a loan (Braun, 2003).

Another finding of the CNI's survey is that 73% of large exporting firms confirm encountering difficulties when exporting. This result puts into perspective the literature suggesting a positive link between firm size and firm's export performances. While the link between firm size and firm's exports seems to be evident, the distortions in the Brazilian market could alter this positive relation. As said before, the Brazilian context -characterized by a high cost of capital and underdeveloped financial institutions- results in a problem of credit availability. This negatively affects firms' investments, notably those related to exporting activities which require in some cases important up-front costs. These constraints could be even stressed after the recent crisis of 2008, due to controls of capital implemented by the Brazilian government (Alfaro et al, 2014).

The literature generally associates large firms with softer credit constraints. Using panel data for Brazilian firms for the period 1986-1997, Terra (2003) finds 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 largest firms and for multinational companies. Besides, Crisostomo et al (2012) confirm, through a study on a panel of 289 nonfinancial firms over 1995-2006, that credit constraints impede firms' investments, especially for smaller firms. Investments of small firms are found to be more reliant on *internal* funds, compared with large firms. These results are confirmed in Kumar and Francisco (2005), who analyze the findings of the Investment Climate Assessment Survey conducted by the World Bank in 2003. If large Brazilian firms are meant to be less constrained, one would thus question about the efficacy of BNDES targeting. In fact, while the BNDES is supposed to relax financial constraints, its disbursements do not seem to target the most credit constrained firms. To illustrate this idea, Appendix A shows that BNDES disbursements go especially for large firms and not small and medium ones. Regarding the link between firm size and being constrained, Aldrighi and Bisinha (2010) propose an opposite view. The authors find that the sensitivity of investment to internal cash flows increases with the firm size, suggesting that credit constraints are higher for large companies. More recently, Faleiros (2013) proposes that while the large size of a firm, being listed and export capacity are associated with less credit constraints, small firms can also exhibit higher export revenues. These results make it interesting to *revisit* the link existing between, firm size, credit constraints and export performances of Brazilian firms.

3 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). Similarly, a body of literature has been interested in the effects of financial development on export performances. In particular, it has been demonstrated that the quality of financial institutions presents a comparative advantage with regards to exports, especially in industries with higher external capital needs (Kletzer and Bardhan, 1987; Beck, 2003; Hur et al, 2006). 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 a similar access to the external finance for firms within a country (Minetti and Zhu, 2011).

More recently, a growing body of literature has been interested in the effects of financial constraints on *firm* export behavior. 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 fixed costs before entering the international market. These costs include market exploration, creation of subsidies in the foreign markets, etc. Taking these elements into account, Melitz (2003) proposes a model of heterogeneous firms, in which entering the export market requires the payment of up-front costs that can be seen as an investment. This model suggests that, in a context of perfect financial markets, only *productive* firms can enter the export market. This model has been then extended to allow for imperfect financial markets. For instance, Manova (2013) assumes that exporters should borrow funds from the financial system to finance a part of their costs related to the export activity, and present collaterals. The financial frictions affect the export participation (extensive margin of trade) and the export performances (intensive margin of trade), as well. Their effects on productivity cut-offs are found to be more pronounced for firms in sectors with higher external financing needs, especially in countries with poor financial institutions. Similarly, Chaney (2013) considers credit frictions as determinants of exports at firm-level. The author argues that liquidity constraints are linked to the firm's productivity: more productive firms have larger profits and, they are consequently less constrained. Despite the differences in terms of financial constraints' assessment, both works have pointed the weight of firms' characteristics in the span of liquidity constraints they may face.

These theoretical contributions to the literature on international trade have been supported empirically. Using data on a panel of UK manufacturing firms over the period 1993-2003, Greenaway 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 (2010) provide evidence that liquidity constraints do affect exports in 9 emerging countries. To proxy liquidity constraints, the authors use some variables and ratios from firms' balance-sheets. Similar results are found by Minetti and Zhu (2011) who made a survey to get information on credit constraints and export volumes for small and medium Italian firms. The authors define two measures that reflect two different intensities of credit rationing. Their results also suggest that the effects of credit rationing on the participation to export and the overall sales, differ across firms and sectors. Bellone et al (2010) also analyze the importance of financial constraints in explaining firm export behavior using French data. The authors construct measures of firm-level financial constraints based on size, profitability, liquidity, cash flow generating ability, solvency, trade credit over total assets, and repaying ability, following Musso and Schiavo (2008). Their findings confirm the importance of better a access to finance in explaining firms' export behaviors.

As proposed by Manova (2013), financial constraints are even sharper for firms operating in sectors with high external finance needs and/or few tangible assets. This innovation is initially suggested by Rajan and Zingales (1998, henceforth RZ) who define a sector-level index of external finance dependence, based on US firm-level data. This index has been then used to assess financial constraints at sector-level. Based on this innovation, Manova et al (2011) use detailed data on Chinese exporters in 2005 and find that multinational and joint venture companies export more than domestic firms, especially in sectors with high external finance needs. The importance of financial constraints with regards to international trade performances has been highlighted during the recent crisis of 2008. Bricongne et al (2010), for instance, show that during the global crisis, the exports of French firms in financially vulnerable sectors were more affected. Paravisini et al (2012) focus on the *supply* side of credit during the crisis, and show using data on Peruvian banks, that a shrink in credit supply by the Peruvian banking system causes a reduction in export volumes but does not significantly affect the extensive margin of trade. Their findings show however a constant elasticity of exports to credit across the different characteristics of firms, sectors or export flows. These different results make it interesting to consider the intersectoral heterogeneity in terms of needs of external finance when studying the effects of financial constraints on export performances.

Focusing on financial constraints at firm-level, a wide range of measures are proposed in the literature. The sensitivity of investment to cash flow has long been used as a proxy for liquidity constraints (Fazzari et al, 1988). The pertinence of this measure has however been questioned in the literature (Kaplan and Zingales, 1997; Bellone et al, 2010). Alternative firms' characteristics have been suggested as proxies for credit constraints. As detailed before, Manova et al (2011) consider firm ownership as a proxy of firm constraints. Multinational companies can be financed in the domestic market and in foreign markets, which makes them

have better access to finance compared with domestic firms. Firm size has also 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. Large firms are thus generally associated with less credit constraints. Given the market failures that characterize Brazil, the link between financial constraints and firm size could be altered. This paper adds to the literature on financial constraints by considering firm size of Brazilian exporting firms as a measure of financial constraints.

Moving to the link between firm size and exports, the proposition that firm size is positively associated with export performances is often taken for granted. However, the literature does not definitively support this proposition. Based on a survey of Thai exporting firms, Archarungroj and Hoshino (1998) find that larger firms do not evidently perform better than smaller firms. Moreover, Verwaal and Dronks (2002) find that the positive link between firm size and export intensity is affected by the size of export relationship. More recently, Berthou and Vicard (2013) find, using French data, that the effect of firm size on the export growth of surviving exporters is non-monotonic. These results contradict the common perception about the link between firm size and export performances. This paper contributes to the literature on the effect of firm size on export performances, with a focus on Brazilian exporters. This question is particularly relevant for the Brazilian case, since an important number of large firms in the Brazilian CNI’s survey declared that they encounter difficulties to export, as detailed in Section 2.

4 Data

4.1 A database on Brazilian exporters in 2010

I use data from two main sources. Data on Brazilian exporting firms come from the Brazilian Secretary of External Trade (*Secretaria de Comercio Exterior*, SECEX). Data on firm characteristics come from the Annual List of Social Information (*Relação Anual de Informações Sociais*, RAIS), a database of the Brazilian Ministry of Labor and Employment.

Data on annual firm-level exports in 2010 are provided by the SECEX. This secretariat records every legally registered export transaction from Brazilian firms. The SECEX provides information on all exporting firms. Data are provided at the plant-level⁴. Each establishment is identified by a unique 14-digit tax identifier CNPJ (*Cadastro Nacional de Pessoa Jurídica*). Detailed data on exports are confidential. I only make use of the publicly available data. These include the export value range in U.S. dollars (FOB) and the region in which the firm operates⁵. Five export ranges are defined by the SECEX: less than \$1 million, between \$1

⁴Different establishments of a same company are considered as distinct entities.

⁵Information on regions will permit to control for the region heterogeneity in terms of economic and financial development, that characterizes the Brazilian economy.

million and \$10 million, between \$10 million and \$50 million, between \$50 million and \$100 million and more than \$100 million. Given that the coverage of export data is limited in the Worldscope data, access to data from the customs service SECEX is a key differentiator of this study (Alfaro et al, 2014). Using data on exporting firms in 2009, I also get information about the survivors in 2010, i.e. firms that remain present in the export market in 2010.

The present empirical study accounts for financial constraints at industry-level; therefore, I need to get information about the sectors in which exporting firms operate. To do that, I match the legal identifiers of the firms in my sample (CNPJs) with the sectors in which these firms *mainly* operate, using data from the Brazilian Ministry of Finance (*Receita Federal do Brasil*). This step required hand data collection from the website of the Ministry of Finance. Industries are classified following the Brazilian national classification of economic activities CNAE 2.0. I restrict my sample to exporting firms for which the main activity relates to the *manufacturing* sector, i.e. in the subclasses ranging from 10 to 32. Note that a firm can export different products in different sectors. Here, due to data unavailability on the details of the different goods a firm exports, I assume that a firm's exports are of goods that correspond to its main economic activity. Although this assumption is restrictive, it is unlikely to bias my 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 get 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 (*Matriz*) in Brazil or an affiliated establishment (*Filial*). I use these data in order to capture the differences between parent firms and affiliated companies in the access to external finance. Here, the term "parent" does not necessarily refer to the headquarter company; it rather refers to the first establishment of a company (Brazilian or foreign) in Brazil.

Data on firm size are provided by RAIS database. This database covers annual social information on Brazilian firms in the formal sector. Available data cover 2009-2011⁶. These data include the number of employees and the wage bill in Reais R\$, at plant-level. These variables are considered as proxies for firm size. Additional data on firm size are obtained from ORBIS database, provided by Bureau Van Dijk for the OECD and gathering firm level data for over 7 million firms all over the world. The data available include a size indicator with four levels: small, medium, large, and very large. The definition of the size is based on a number of proxies of size: the number of employees, firm turnover, total assets and being listed (See Appendix B). This size indicator is used in the robustness checks section.

I then move to data on industry measures of financial constraints. In order to capture intersectoral heterogeneity in terms of financial vulnerability, I create two measures of sector reliance on external funding based on Brazilian data. Following the methodology of RZ, I first compute indexes of sector-level dependence on external finance, denoted *ExtFinBra_s*.

⁶I need to thank Marta dos Reis Castillo, Universidade Federal do Rio de Janeiro, for facilitating the access to this database.

These indexes are computed using data on Brazilian publicly traded firms on BM&F Bovespa, the Brazilian Stock exchange over the period 2000-2012⁷. For each firm, the index is defined as the part of capital expenditures that is not financed by internal funds, i.e. the operating cash-flows of the firm⁸. To compute firm-level indexes, data⁹ are averaged over the period 2000-2012. This permits to smooth the variations over time and the effects of extraordinary events, such as the financial crisis of 2008. The sector-level index corresponds then to the median value of this index, when considering publicly traded firms that operate in the given sector. The indexes of RZ have been computed over US data in the 1980's. These indexes have been then used to proxy the intersectoral external finance needs in other countries and over different periods of time (Ouro 2008; Manova et al, 2011). This has been motivated by the quality of the american financial system. In fact, RZ assume that the US financial system is considered as the most developed and then it is assumed to ensure the best capital allocation between sectors. In line with this view, the financial dependence index will be considered as representing the sectors' needs of finance based on their *technological* differences. In other words, RZ indexes are assumed to reflect the sectors needs of finance, based on their *inherent* technological characteristics¹⁰. Taking into account the differences in terms of financial development between Brazil and the United States, the Brazilian indicators would not precisely reflect the financial needs based on the technological component. They would rather represent the *access* of the different Brazilian sectors to external finance after accounting for their technological needs (*demand side of credit*) and the Brazilian financial market imperfections that affect the *supply* of credit¹¹, as well. In this way, the use of Brazilian indexes based on Brazilian data in over the last decade would be an attempt to better assess the dependence of Brazilian manufacturing industries on outside capital. These indicators are presented in Appendix C (Table C.1).

The second measure is the level of asset tangibility, denoted $TangBra_s$. This measure has been initially proposed by Braun (2003) and is defined as the part of tangible assets in total assets. Based on the quality of the US financial market, Braun (2003) computes asset tangibility measures over data on US publicly traded firms in the 1980s. As for external finance dependence indicators, the sector level of asset tangibility corresponds to the median value of the ratio of asset tangibility after considering all the firms operating in the given sector. Asset tangibility indicators are supposed to be inversely correlated to external finance dependence indicators. Financial constraints can be relaxed for Sectors with more tangible assets, since firms in these sectors can present their tangible assets as collaterals, when seeking for external

⁷The use of data on publicly traded firms is motivated by the common perception that these firms are less likely to be credit constrained.

⁸The use of data on publicly traded firms is motivated by the common perception that these firms are less likely to be credit constrained.

⁹for each variable.

¹⁰This assumption is debated in a forthcoming paper that discusses the pertinence of RZ indicators when studying the sector financial needs in other countries and over other periods of time.

¹¹Financial market imperfections in Brazil result in a misallocation of capital which may affect the access of manufacturing sectors to finance, and their dependence on external finance by consequence.

capital. In this way, asset tangibility measures are considered to be reflecting the ease of access to finance. Using data on publicly traded firms in BM&F Bovespa,, I compute asset tangibility measures for Brazilian industries over the 2000s. These measures are displayed in Appendix C (Table C.1). Based on a correlation test¹², these measures are found to be *positively* correlated with Brazilian measures of external finance dependence. This suggests that sectors which can rely on external funds are those that present many tangible assets. Given the Brazilian context, this finding informs about the ease of *access* to credit in Brazil, rather than the *inherent* needs in terms of outside capital. In order to capture more characteristics of the Brazilian financial sector, I also make use of data on BNDES disbursements per sector in 2010, as a control variable. These data are provided at a monthly basis by the BNDES.

I finally consider the *inherent*¹³ needs of industrial sectors by using US indicators of external finance dependence and of asset tangibility borrowed from the literature. These indicators have been originally proposed for US manufacturing sectors over the 1980-1989 by RZ and Braun (2003), respectively. In this study, I consider however their updated values from Kroszner et al (2007, See Appendix C, Table C.2). The authors computed these indicators denoted $ExtFinUS_s$ and $TangUS_s$ using US data, over 1980-1999. They also propose R&D intensity as a proxy for sector-level financial needs. This measure ($RDUS_s$) is defined as the share of R&D expenses in the total sales, and also computed over 1980-1999. In fact, R&D expenditures are incurred at the beginning of the production process and are considered as up-front fixed costs, which are in general large costs especially when the product will be distributed in a foreign market (Manova, 2013). I focus on measures provided by Kroszner et al (2007) in order to guarantee the comparability between different measures of financial vulnerability¹⁴. In fact, while these indicators are supposed to reflect intersectoral heterogeneity in terms of financial needs, *stable in time*, there exist some factors that may affect the stability of intersectoral differences, in time¹⁵.

4.2 A first glance at Data

Before going into the econometric analysis, I begin by presenting statistics of the database on Brazilian exporting firms in the manufacturing sector, in 2010. First, there are 20137 exporting firms recorded by the SECEX in 2010. Among them, 12964 companies operate in the manufacturing sector. Due to data unavailability, the final sample of exporting firms considered in this study is of 12556 exporting firms, which represents a comprehensive sample of manufacturing Brazilian exporters in 2010. Focusing on the sector composition of export-

¹²Pairwise correlation test shows a correlation of 51% between Brazilian indicators of dependence on external finance and thos of asset tangibility, significant at 5%. Spearman tests show however a weak positive but non-significant correlation between both indicators.

¹³Based on the quality of financial institutions in the US, the US market is considered as the *least distorted* financial market. Therefore, intersectoral differences in terms of external finance needs in the US are considered as benchmarks and as reflecting as precisely as possible intersectoral *technological* differences.

¹⁴computed over the same period 1980-1999.

¹⁵This issue is treated in a forthcoming paper that discusses the pertinence of RZ indicators when studying the sector financial needs in other countries and over other periods of time.

Table 1: Export Performances, Export Status and Legal Status

Interval of Exports in million US\$	New Exporters			Survivors			Total
	All	Parent	Affiliated	All	Parent	Affiliated	
Exports < 1	1983	1739	244	6844	6151	693	8827
1 < Exports < 10	115	53	62	2420	1849	571	2535
10 < Exports < 50	32	10	22	787	444	340	819
50 < Exports < 100	5	0	5	175	86	89	180
Exports > 100	7	2	5	188	75	113	195
Nb. Obs.	2142	1804	338	10414	8605	1806	12556

ing firms in 2010, Machinery and Equipment, Food products, and Chemicals are the most represented in the sample (Appendix D, Table D.1). Summary statistics on all variables in this study are displayed in Appendix D (Table D.2). In Table 1, I present some descriptive statistics for the whole sample and also using different firms' classifications. A first remark is that the majority of Brazilian exporters export less than 1 million US\$. The number of exporting firms decreases with the export ranges. These exporting firms are then classified depending on their export status into "New Exporters" for those that did not export in 2009 and "Survivors" for those which have already exported in 2009. The descriptive data show that exporters in 2010 are mainly survivors. This finding corroborates the low entry rate to the export market, which characterizes the Brazilian market (Cebeci et al, 2012; Canuto et al, 2013).

I also classify firms according to their legal status separating those corresponding to first establishments in Brazil (Parent) from affiliated establishments (Affiliated). Exporting firms in 2010 are mainly first establishments in Brazil. Note that due to data unavailability, this study does not consider the capital ownership effect on export performances.

In Table 2, I present some descriptive statistics on the exporters' characteristics, mainly those related to firm size. Consistently with the empirical literature on export performances, I find that Survivors tend to be significantly larger and to present higher wage bills and higher wages. Larger firms are more likely to generate revenues and to meet the financial needs related to the exporting activity, which makes them more likely to remain active in the exporting market. These statistics could also inform about the potential *learning by doing* effects, through which the exporting activity makes firms larger. Focusing on the legal status, it seems that Affiliated exporting companies are larger and pay higher wages, compared with main establishments. This finding could be explained by Brazilian firm strategies related to tax legislation.

I finally divide the sample of firms into firms operating in sectors with high *inherent* external finance requirements (High Dep.) and those operating in sectors with negative external finance dependence (Low Dep.)¹⁶. Table D.3 in Appendix D suggests that exporters operating

¹⁶Sectors with a positive value of $ExtFinUS_s$ are considered as dependent on external finance. The remaining sectors are considered to have negative external finance dependence.

Table 2: Firm Size, Export Status and Legal Status

Variable	All	Export status		Legal status	
		Survivors	New Exporters	Parent	Affiliated
Number of Employees	216.9817	582.1265	102.415	171.6208	437.2696
Wage Bill	508591.5	1836623	205744.7	394181.6	1064206
Wage Per Worker	2191.312	8895.562	1805.907	2103.427	2626.456
Nb. Obs.	12556	10414	2142	10412	2144

in external finance dependent sectors tend to be slightly larger than those operating in sectors with low external capital needs. These statistics do not allow however to give precise conclusions about the importance of firm size depending on sector-level financial constraints. The importance of firm size coupled with sector-level financial vulnerability in explaining Brazilian exports will be properly discussed in the following sections.

5 Empirical Analysis

In this section, I begin by presenting a simplified framework of heterogeneous firms in a context of imperfect financial markets. I then present the main specification of the paper. Finally, I discuss the methodology of estimation which fits available data.

5.1 Theoretical framework

The literature has provided a number of theoretical frameworks in which credit constraints affect international trade patterns differently across sectors and countries. Here, I consider a simplified framework inspired from Manova (2013). This framework is based on the predictions of Melitz (2003) extended to account for financial market imperfections.

Entering the foreign market requires the payment of up-front costs including lands, equipment, marketing adaptation, commercialization channel, in order to make the foreign activity possible. Moreover, the exporting activity is generally associated with higher needs for liquidity, compared with domestic activities. Given these facts, assume that exporters need to borrow capital from the financial market, by pledging collateral. The probability for the contract between the exporting firm and the financial market to be enforced depends on the level of financial development in the exporting country. If the contract is enforced, the firm repays the investor; otherwise, the creditor claims collateral. The level of dependence on external finance and the availability of tangibles assets (*collateralizable* assets) differ however across sectors. This makes some exporters more credit constrained than others. In presence of these financial constraints, the productivity cut-off above which the exporting activity becomes efficient is higher than the threshold in the absence of financial frictions.

If firms require external funds to finance a part of their fixed costs only, liquidity constraints will then only affect their selection into the export market. However, when firms require raising outside capital in order to finance a part of their fixed and variable costs, credit constraints

will affect the selection into exporting and the value of their exports, as well. Unlike most productive exporters, less productive and more constrained firms will not be able to export at first-best and will be more likely to ship lower quantities. By lowering export volumes, these firms lower their variable costs which make them need less outside funds, depending on their sector of activity of course. Since the aim of this paper is to analyze the *intensive* margin of trade, I assume that firms need external capital to finance both their fixed and variable costs.

In a context of firm heterogeneity with perfect financial markets, the size of the exporting firm could be associated with higher productivity. Financial market frictions do however create distortions to the link between firm size and productivity. In presence of financial imperfections, firm size would be rather considered as a measure of liquidity constraints. Firm size is generally considered as a convenient approximation of firm resources, notably financial ones. Unlike small firms, large firms are supposed to generate larger cash-flows, which make them less credit constrained (Chaney, 2013). Moreover, in the presence of financial frictions, the literature proposes that the adverse effects engendered by information asymmetries can be reduced by the provision of collateral (Angelini et al, 1998). Since large firms tend to have more assets for collateral, their access to finance would be facilitated. Consistent with this idea, larger firms in Brazil are found to have better access to credit (Kumar and Francisco, 2005). Given these elements, firm size is considered to reflect the ability to access to finance. As said before, there are intersectoral differences in terms of external financial needs, which may affect firms-level financial constraints. The common perception predicts that the advantage related to firm size is stressed in sectors with higher financial needs. Larger firms would have easier access to finance which makes them more likely to better perform in sectors with higher external finance needs, compared to smaller firms. However, when accounting for the Brazilian context, this relation would be altered. The Brazilian market is characterized by a high cost of capital that may hamper investment activities of firms with higher needs of external capital, even if they are large-sized firms.

To summarize, I consider that companies require external funds to finance both fixed and variable costs and I will be particularly interested in the study of the value of exports of Brazilian exporters. I expect that credit constraints, impede the intensive margin of trade. These effects should be reduced for larger firms. The importance of firm size in financially vulnerable sectors is however mitigated, given the particularity of the Brazilian context.

5.2 Main specification

The purpose of this analysis is to assess the effects of financial constraints on export performances of Brazilian exporters. The estimation strategy is based on the idea that large firms are less credit constrained than smaller ones, and that the effect of sector level financial vulnerability on export performances varies across firm sizes.

I thus study the variation in trade flows depending on the firm size and the sector in which the exporting firm operates with the following specification (1):

$$LEXP_f = \beta_0 + \beta_1.Lsize_f + \beta_2.Lsize_f \times FinVul_s + \beta_3.Parent_f + \beta_4.Exp09_f + \varphi_s + \varepsilon_f \quad (1)$$

where $LEXP_f$ is the (Log) value of exports in US\$ of firm f (in all industries and across all destinations) in 2010, which is an unobservable (latent) variable. As detailed in **Section 4**, the SECEX provides *rather* ranges of export values. The characteristics of this dependent variable will be dealt with in the methodological **Subsection 5.3**. $Lsize_f$ is a variable indicating the size of the firm f in 2010¹⁷. Two proxies of firm size are considered: the (Log) number of employees $lemployees_f$ and the (Log) value of wage bill $lwageb_f$. Considering that larger firms are less credit constrained and that they generate larger revenues, β_1 is then predicted to be positive. $FinVul_s$ measures the sector s 's level of financial vulnerability in Brazil. I use two proxies for the financial vulnerability described above: the external finance dependence indicators for Brazilian manufacturing industries computed over the period 2000-2012 ($ExtFinBra_s$) and the level of asset tangibility for Brazilian sectors computed over the same period ($TangBra_s$). $Parent_f$ is a dummy variable that controls for the legal status of the exporting firm f . This dummy takes the value of 1 if the firm corresponds to the *first* plant of a given company (domestic or foreign) established in Brazil, and 0 otherwise. $Exp09_f$ is a binary variable that controls for the export status of the firm f . This variable equals 1 when the exporting firm in 2010 has been already an exporter in 2009 (Survivor) and 0 if the firm is a new exporter. This variable may control for the entry rate to the foreign market and for the firm's financial constraints, as well. In fact, as proposed in the theoretical framework described above, entering the export market requires the payment of sunk fixed costs. Being already an exporter in 2009 could be then seen as a form of financial constraints' relaxation in 2010, since the exporter would have paid, in principal, the important part of export-related fixed costs in 2009 or earlier. Thus, β_4 is expected to be positive. Finally, I include sector-level fixed effects φ_s that capture all the characteristics inherent to manufacturing sectors in Brazil, including the need for external finance. Since the study is in cross-section, φ_s would also capture information on the level of financial support obtained by the sector in 2010. Here, I particularly refer to the government intervention into the financial sector through BNDES public loans. Since data on exports are at plant-level, further firm groups effects would be interesting to add, in order to capture the managerial strategy of the company and the allocation of resources across different plants. However, due to technical constraints, these effects cannot be included¹⁸.

¹⁷One could use the value of firm size in 2009. This would however have engendered a loss of observations on exporting firms in 2010.

¹⁸In this paper, a problem would arise when including firm groups fixed effects. In fact, I could have a problem related to the number of degrees of freedom since among 12556 observations, there are more than 12000 distinct groups of firms.

The main coefficient of interest is the interaction term between firm size and the financial vulnerability of the sector. β_2 reflects the allocation of capital resources in Brazil across sectors with different levels of reliance on external capital. Specifically, β_2 quantifies the effects of credit constraints on firm exports. While a firm's access to finance may be endogenous to the trade activity, including the financial constraints at sector-level helps establishing the causality (Rajan and Zingales, 1998). If credit constraints impede trade, I then anticipate that financially vulnerable sectors export less. Considering the effect of firm size however, two interpretations could be presented. In principal, larger firms are less credit constrained compared with smaller ones and they are by consequence, supposed to be more performant in sectors that highly depend on external finance ($\beta_2 > 0$). In fact, large firms are generally considered as more productive, which make them favored by the financiers (Manova et al, 2011). However, considering the Brazilian context characterized by problems in credit supply, larger firms may encounter bigger problems in access credit compared with small firms. Due to their size, large firms are by nature likely to demand higher amounts of external finance, which makes them more external finance dependent. Their export performances can be then more restricted when they operate in financially vulnerable sectors, which will translate into a negative β_2 ($\beta_2 < 0$).

Given the nature of the dependent variable in this study, the estimation using standard strategies is not appropriate. The following paragraph will discuss the methodology that better fits this kind of dependent variable: Interval regression.

5.3 Methodology: Interval Regression

In this paper, the dependent variable takes the form of ranges of export values (in million US\$) and not an exact value of exports. Given this, the use of standard estimation techniques in cross-section models, such as Ordinary Least Squares (OLS) and difference-in-difference (Manova et al, 2011), may become inappropriate. While the exact value of exports of firm f noted EXP_f is non-observable (latent), the SECEX provides export data using five ranges. These ranges of exports denoted $ExportRange_j$ ($j = 1, \dots, 5$) are defined (in million US\$) by two limits $\{Inf, Sup\}$:

$$\left\{ \begin{array}{l} ExportRange_1 \{-\infty, 1\} \text{ if } EXP_f < 1 \\ ExportRange_2 \{1, 10\} \text{ if } 1 \leq EXP_f < 10 \\ ExportRange_3 \{10, 50\} \text{ if } 10 \leq EXP_f < 50 \\ ExportRange_4 \{50, 100\} \text{ if } 50 \leq EXP_f < 100 \\ ExportRange_5 \{100, +\infty\} \text{ if } EXP_f \geq 100 \end{array} \right\}$$

Considering the characteristics of data, the estimation of an Interval Regression model will be appropriate. This methodology is an extension of the Tobit model, in which the dependent variable is censored. As in models with discrete choices, maximum likelihood estimation is employed.

The likelihood function is defined as follows:

$$\begin{aligned}
L = & \prod_{EXP_f < a_1} \left[\Phi \left(\frac{a_1 - X' \beta}{\sigma} \right) \right] \prod_{a_1 < EXP_f < a_2} \left[\Phi \left(\frac{a_2 - X' \beta}{\sigma} \right) - \Phi \left(\frac{a_1 - X' \beta}{\sigma} \right) \right] \\
& \times \prod_{a_2 < EXP_f < a_3} \left[\Phi \left(\frac{a_3 - X' \beta}{\sigma} \right) - \Phi \left(\frac{a_2 - X' \beta}{\sigma} \right) \right] \times \\
& \prod_{a_3 < EXP_f < a_4} \left[\Phi \left(\frac{a_4 - X' \beta}{\sigma} \right) - \Phi \left(\frac{a_3 - X' \beta}{\sigma} \right) \right] \\
& \times \prod_{EXP_f > a_4} \left[1 - \Phi \left(\frac{a_4 - X' \beta}{\sigma} \right) \right] \tag{2}
\end{aligned}$$

where $\Phi(c)$ is a normal cumulative function. σ will be estimated and has not to be normalized to 1, as in probit models. a_1, a_2, a_3 and a_4 are *known* cut points corresponding to 1, 10, 50 and 100 million US\$, respectively. The model is then set up as follows:

$$Pr [a_j < EXP_f < a_{j+1}] = \Phi(a_{j+1}) - \Phi(a_j) \quad j = 0, \dots, 4; \quad a_0 = -\infty; a_5 = +\infty \tag{3}$$

In order to estimate this model, the dependent variable in Eq. (1) is then replaced by two variables: *Inf* and *Sup* (in Log). The equation to be estimated becomes:

$$\{LInf_f, LSup_f\} = \beta_0 + \beta_1.Lsize_f + \beta_2.Lsize_f \times FinVul_s + \beta_3.Parent_f + \beta_4.Exp09_f + \varphi_s + \varepsilon_f \tag{4}$$

where *LInf_f* and *LSup_f* are the (Log) values of the inferior and superior limits of the interval of export value (defined in million US\$) to which the firm *f* belongs. Using the Interval regression method, the estimated β 's are then interpreted as in standard OLS in terms of elasticity (Conroy, 2005).

The model presented by Eq. (1) can be also estimated using an Ordered Probit model. The dependent variable would be a categorical variable noted *ExportClass_j* ($j = 1, \dots, 5$) and defined as follows:

$$\begin{aligned}
ExportClass_1 &= 1 \text{ if } EXP_f < 1 \\
ExportClass_2 &= 2 \text{ if } 1 \leq EXP_f < 10 \\
ExportClass_3 &= 3 \text{ if } 10 \leq EXP_f < 50 \\
ExportClass_4 &= 4 \text{ if } 50 \leq EXP_f < 100 \\
ExportClass_5 &= 5 \text{ if } EXP_f \geq 100
\end{aligned}$$

The conditional probability of exporting in a given $ExportClass_j$ will be defined as follows:

$$P(ExportClass_j | Observed\ variables)_f = \beta_0 + \beta_1.Lsize_f + \beta_2.Lsize_f \times FinVul_s + \beta_3.Parent_f + \beta_4.Exp09_f + \varphi_s + \varepsilon_f \quad (5)$$

In this case, the likelihood function to be estimated is:

$$L = \prod_{i=1}^{N_1} F(\mu_1 - X' \beta) \times \prod_{N_1+1}^{N_2} F(\mu_2 - X' \beta) - F(\mu_1 - X' \beta) \times \prod_{N_2+1}^{N_3} F(\mu_3 - X' \beta) - F(\mu_2 - X' \beta) \times \prod_{N_3+1}^{N_4} F(\mu_4 - X' \beta) - F(\mu_3 - X' \beta) \times \prod_{N_4+1}^N 1 - F(\mu_4 - X' \beta) \quad (6)$$

where $F(c)$ is the standard normal cumulative distribution function and the μ 's are unobserved thresholds to be estimated with β 's. They are values of exports that define the limit between two different categories of $ExportClass_j$. Ordered Probit estimation assumes that the ε_f is normally distributed across observations and requires the mean and the variance of ε_f to be normalized, so that $\varepsilon_f \rightsquigarrow N(0, 1)$.

Considering that, two differences between interval regression and ordered probit can be highlighted. First, in Interval regression, σ is estimated and has not to be normalized to 1. Second, when considering intervals of exports, the cut points are known, whereas, in ordered probit model, they need to be estimated. The use of ordered probit model when having data on well-defined intervals would then result in a loss of information. Based on these two differences, the literature considers that interval regression estimators are more efficient than those of ordered probit model (Cameron and Huppert, 1991; Conroy, 2005). Note that Interval Regression estimation requires a normality assumption, here the log normality of exports EXP_f . In order to check this assumption, the performance of ordered probit estimation would be appropriate (Conroy, 2005). Thus, ordered probit estimations will be used as robustness checks.

To my knowledge, Interval regression method has not been used in the field of international economics. There are however a number of economic studies that have used this kind of method, especially when dealing with revenues or earnings. Yang et al (2012) study the consumers' willingness to pay for fair trade coffee in China. This study is based on a survey in which respondents are asked to choose an interval of prices they are willing to pay for fair trade coffee, among 16 price ranges proposed. Similarly, Yan et al (2014) use interval regression methodology to analyze Shanghai customers' willingness to pay for the safer baby cheese. More recently, Sim (2015) makes use of interval regression method in order to estimate the effects of university education on earnings in China. Data on earnings are provided in intervals by Chinese National Youth Survey. Given the relatively few papers using interval

regression, the present paper would provide a methodological contribution to the literature on international economics.

6 Effects of firm size on Exports across Brazilian sectors

In this section, I present the results of the empirical analysis of the effects of financial constraints of Brazilian exporters on their export performances in 2010. A number of robustness checks are then presented. I also test the impact of the characteristics of the Brazilian context, notably the tax incentives (based on the legal status of the firm) and the regional heterogeneity, on firm-level exports.

6.1 Main Results

I begin by presenting the main results of Eq. (4) using the interval regression estimation. Table 3 presents the baseline results using the main measure of firm size $Lemployees_f$. Columns 1-4 consider the level of external finance dependence of Brazilian sectors as a measure of financial constraints at sector-level. The remaining columns consider Brazilian measures of sector-level of asset tangibility. The results show that, consistent with the common perceptions, Brazilian larger firms export more than small firms. Large firms are generally considered as less credit constrained, which makes them more likely to have better export performances compared with smaller firms. The advantage related to firm size is however found to be reduced when firms operate in sectors with higher needs of external capital. Although large firms are more likely to have access to credit due to their assumed productivity and performance, the importance of firm size in explaining trade declines in financially dependent sectors.

This finding can be attributed to the imperfections of the Brazilian financial sector. Due to these imperfections, the *access* to credit of the different manufacturing sectors in Brazil would be affected by the problems in the supply of credit that characterize the Brazilian market. Given that, $ExtFinBra_s$, computed over Brazilian data, would reflect not only the *needs* of external capital (demand side), but also the ability to *access* to finance (supply side). This measure can then inform about the intersectoral heterogeneity in terms of *access* to external finance in Brazil. Recall that the original indicators of external finance dependence proposed by RZ are computed over US data and are then assumed to reflect as precisely as possible an efficient allocation of capital between sectors, given the quality of US financial sector. This makes RZ indicators precisely inform about sector-level *needs* of external finance, mainly based on their *inherent* technological characteristics. In Brazil however, due to financial frictions, the allocation of capital resource could be oriented towards sectors that do not highly rely on outside capital. In other words, the amounts of external finance firms get from the financial sector could be different from those these firms demanded. This leads Brazilian indicators to reflect sector-level financing problems rather than their inherent financial needs. Brazilian external finance dependence measures $ExtFinBra_s$ would also capture further financial frictions in Brazil, such as the effects of large capital inflows over the 2000s, notably in 2000 and

2007 (Benigno et al, 2015). Consistent with this idea, Reis (2013) argues, through the analysis of the Portuguese market, that the weaknesses of financial systems result in a misallocation of capital inflows and a shift of capital resources out of sectors producing tradable products, and towards non-tradables. This makes $ExtFinBra_s$ informs about the *ease of access* to external finance. Sectors with higher levels of $ExtFinBra_s$ are sectors which can have easier access to finance. Given that, $\beta_2 < 0$ in Eq. (4) informs that the advantage related to firm size with regards to export performances is reduced when firms operate in sectors with a high reliance on external finance, i.e. easier access to finance. This result can be justified by the fact that when firms operate in sectors which are favoured by the Brazilian financial system, the size of the firm matters less with regards to the access to credit. I then move to the interpretation of results based on the second measure of financial vulnerability: $TangBra_s$. Recall that this measure is supposed to be inversely correlated with the sector-level financial vulnerability, since tangible assets are *collateralizable* (Braun, 2003). Note however that this relation is found to be positive when considering Brazilian measures of financial vulnerability. This finding attests of *specific* characteristics of Brazilian industries in terms of financial vulnerability and access to finance. Considering the Brazilian context, sectors that present high levels of asset tangibility are those which can be more reliant on external finance. In this regard, Claessens and Sakho (2013) point the importance of the availability of collateral in the access to credit for firms in Brazil. Focusing on Columns 5-8 of Table 3, the results show that the advantage related to the firm size decreases when firms operate in sectors with many tangible assets. This result is consistent with the predictions in the literature on financial constraints ($\beta_2 < 0$). Large firms outperform smaller ones in terms of export performances, by less in sectors with many hard assets. The rationale is that in these sectors, the availability of tangible assets is considered as a form of credit constraints *relaxation*, which makes the importance of firms' characteristics lessened, with regards to the access to credit.

Table 3: Firm Size, Sector Financial Vulnerability and Firm Exports

This table presents the estimation results of the main specification using Interval Regression method. The latent dependent variable is the (Log) value of exports in 2010 and is replaced by two limits of intervals: l_{inf} which corresponds to the log of the value of the inferior limit of the interval and l_{sup} which corresponds to the superior limit. Firm size is proxied with the number of employees. Brazilian measures of sector financial vulnerability are considered. ***, **, * and * denote significance at 0.01, 0.05 and 0.1 levels, respectively.

Dep. Var:	ExtFinBra			TangBra				
	1	2	3	4	5	6	7	8
$LEXP_f (l_{inf}, l_{sup})$								
employees _f	0.95827*** (0.02092)	0.89814*** (0.02059)	0.89814*** (0.02059)	0.84367*** (0.02016)	1.05618*** (0.05101)	1.01811*** (0.04996)	1.01811*** (0.04996)	0.95424*** (0.04917)
employees _f xFinVul _s	-0.01655* (0.00913)	-0.01617* (0.00893)	-0.01617* (0.00893)	-0.01646* (0.00880)	-0.25008* (0.13779)	-0.31722** (0.13500)	-0.31722** (0.13500)	-0.28794** (0.13297)
Parent _f		-0.92268*** (0.06164)	-0.92268*** (0.06164)	-1.00631*** (0.06103)	-0.92833*** (0.06172)	-0.92833*** (0.06172)	-0.92833*** (0.06172)	-1.01132*** (0.06111)
Exp09 _f				1.90211*** (0.10025)				1.90239*** (0.10035)
Constant	8.09750*** (0.16876)	9.21425*** (0.17621)	9.21425*** (0.17621)	7.79010*** (0.19842)	7.83941*** (0.19503)	8.91562*** (0.19961)	8.91562*** (0.19961)	7.50911*** (0.21958)
Observations	12,343	12,343	12,343	12,343	12,343	12,343	12,343	12,343
Sector FE	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Log Likelihood	-8491	-8380	-8380	-8156	-8491	-8379	-8379	-8155
Chi2	4632	4854	4854	5303	4632	4856	4856	5304
Sigma	2.060	2.016	2.016	1.965	2.061	2.017	2.017	1.966

To summarize, the main results suggest that the importance of firm size in explaining export performances decreases in sectors that rely on funds provided by the financial sector. These findings would also inform about the problems of financing large firms and particularly large exporters encounter. This result corroborates the findings of the CNI's survey on Brazilian exporters concerning the difficulties faced by large firms with regards to their export activity. More generally, it seems that large firms do face financing constraints when dealing with their investments. Based on Investment Climate Assessment Survey in 2003, Kumar and Francisco (2005) show that Brazilian firms rely more on internal funds, rather than external capital when financing their projects, *regardless* of the firm size. Considering the common idea that associates investment-cash flow sensitivities to the degree of financial constraints (Fazzari et al, 1988), the results of the survey show then that large firms in Brazil do face constraints. Moreover, Claessens and Sakho (2013) argue, through the analysis of loans provided by the Brazilian central bank, that the access to finance for small firms has been improved over the last decade. These findings would support the results of this present analysis on the reduced importance of being a large firm in explaining trade performances, when operating in sectors with high reliance on outside capital.

In Eq. (4), I also include a number of control variables in order to well capture the effects of financial constraints on Brazilian exporters' performances. Results in Table 3 suggest that Parent plants, i.e. first establishments of firms in Brazil, seem to be less export performant compared with affiliated plants ($\beta_3 < 0$). 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 more 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). It would be more interesting for example to create a plant in Export Processing Zones¹⁹ (EPZ), and to export through this subordinated firm, rather than the main establishment. EPZs are industrial areas intended for exports. In these EPZs, firms benefit from exemption of exports and imports, and from special tax treatment. Firms in these zones must however produce only for exports (PwC, 2010). Moreover, the Brazilian law forbids the transfer of a factory already in operation in Brazil to an EPZ, which makes the creation of secondary establishments required. This form of export incentives would explain the fact that affiliated firms export more than main establishments. In this regard, it is worthy to note that Brazil is characterized by a high tax burden (more than 30% of GDP in 2010), that may create distortions in resource allocation in Brazil (Busso et al, 2012; Vasconcelos, 2015). Export incentives would be then a means for exporting companies to deal with tax collection distortions in the Brazilian market.

¹⁹According to the Brazilian Ministry of Development, a number of EZP have been created in 2010. This may reinforce the relatively higher performances of affiliated firms compared with parent companies in this present study.

Finally, as predicted, the coefficient β_4 is positive and significant and suggests that being an exporter in 2009 positively affects export performances in 2010. In other words, survivors outperform new exporters in 2010. Exporting in 2009 can be seen as a form of financial constraints' relaxation in 2010. As detailed in the theoretical framework, entering the export market requires the payment of sunk fixed costs. Survivors in 2010 are then supposed to have already paid these costs in 2009, or earlier. Therefore, these firms can be considered as less credit constrained in 2010, since they will only have to pay variable costs.

These results remain unchanged when considering the second proxy of firm size: $Lwage_bf$ (See Appendix E). Overall, the results do suggest that financial constraints hamper the export activity of Brazilian exporters in 2010. The firm size does not seem to prevent the effects of financial frictions on the exporting activity. This result can be driven by the Brazilian context, notably the problems in the supply of credit.

This analysis presents two important results. First, this study confirms the role of financial frictions in explaining international trade performances. Second, it provides evidence about the constraints faced by large exporters, in presence of distortions affecting intersectoral allocation of resources. 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 expand the activity to foreign markets (Parente et al, 2013).

6.2 Sensitivity Analysis

6.2.1 Robustness Checks

Further Controls In order to verify the persistence of the effects of financial constraints on Brazilian export performances, I subject the main results to a number of robustness checks. In a world with perfect financial markets, firm size would be a good proxy of firm productivity. In the real world however, financial frictions alter this relation. In order to check if the effects of firm size on trade capture the effects of firm productivity, I include to Eq. (4), an additional control which is the wage per employee $Lwage_bf$. In absence of data on total factor productivity (TFP), I use this variable which would capture the level of labor productivity. In fact, in the literature on export performances, exporters are generally found to be larger, more productive and to pay higher wages. The average wage is also considered as a measure of human capital (Bellone et al, 2010). The results displayed in Table 4 (columns 1-3-5-7) show that the main findings remain unchanged to the inclusion of this variable. Moreover, this variable has the expected positive sign. Consistent with the literature, this result suggests that more (labor) productive firms are more likely to be export performant.

Table 4: Robustness Checks I: Further Controls

This table presents the estimation results of the main specification using Interval Regression method. Two proxies of firm size are considered. Here, I use Brazilian measures of sector financial vulnerability. I also include control variables: region dummies and wage per worker. ***, ** and * denote significance at 0.01, 0.05 and 0.1 levels, respectively.

Dep. Var:	Number of Employees				Wage bill			
	1	2	3	4	5	6	7	8
LEXP _{<i>f</i>} (linf, lsup)	ExtFinBra	ExtFinBra	TangBra	TangBra	ExtFinBra	ExtFinBra	TangBra	TangBra
Lsize _{<i>f</i>}	0.79389*** (0.01967)	0.78516*** (0.01950)	0.95913*** (0.04811)	0.91412*** (0.04788)	0.79938*** (0.01951)	0.79043*** (0.01935)	0.91559*** (0.04563)	0.87361*** (0.04544)
Lsize _{<i>f</i>} xFinVul _{<i>s</i>}	-0.02967*** (0.00864)	-0.02471*** (0.00857)	-0.41783*** (0.13046)	-0.32261** (0.13009)	-0.02485*** (0.00856)	-0.01967** (0.00847)	-0.28562** (0.12169)	-0.20040* (0.12143)
Parent _{<i>f</i>}	-0.83824*** (0.05903)	-0.79676*** (0.05880)	-0.84598*** (0.05910)	-0.80292*** (0.05886)	-0.83810*** (0.05905)	-0.79688*** (0.05882)	-0.84593*** (0.05913)	-0.80248*** (0.05888)
Exp09 _{<i>f</i>}	1.74925*** (0.09726)	1.75982*** (0.09726)	1.74940*** (0.09738)	1.75816*** (0.09733)	1.75033*** (0.09729)	1.76031*** (0.09728)	1.75069*** (0.09737)	1.75938*** (0.09730)
Lwage _{<i>f</i>}	1.02310*** (0.04723)	1.14540*** (0.04851)	1.02006*** (0.04721)	1.14257*** (0.04849)	0.20392*** (0.05052)	0.33872*** (0.05160)	0.19551*** (0.05040)	0.33240*** (0.05151)
Constant	0.53694 (0.40635)	0.30735 (0.42506)	0.11799 (0.42587)	-0.03461 (0.44319)	0.71182* (0.41161)	0.43964 (0.43082)	-0.12918 (0.48957)	-0.18056 (0.50403)
Observations	12,273	12,273	12,273	12,273	12,273	12,273	12,273	12,273
Sector FE	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Region FE	No	Yes	No	Yes	No	Yes	No	Yes
Log Likelihood	-7854	-7791	-7855	-7792	-7856	-7792	-7857	-7794
Chi2	5812	5939	5811	5936	5809	5936	5806	5933
Sigma	1.878	1.859	1.879	1.861	1.878	1.860	1.879	1.861

I also add region dummies in Eq. (4), to control for the region heterogeneity in terms of economic and financial development. In Brazil, there exists a *regional effect* that makes regions differ in terms of access to finance, which may affect firms' investments (Kumar et Francisco, 2005). According to The Brazilian Institute of Geography and Statistics (IBGE), Brazil is divided into five regions: Southeast, South, Central West, North and Northeast. Kumar et al (2004) argue that access to banks is easier in Southeast and South regions. Columns 2-4-6-8 in Table 4 show that the main results hold even after controlling for the regional heterogeneity in terms of access to finance.

The Brazilian government also affects the access to finance. As detailed in Section 2, the Brazilian government offers financial support to Brazilian firms in order to promote the growth of the industrial structure, through the BNDES. This Brazilian public bank offers in fact, low cost financing for investment projects. BNDES Public loans could thus alter intersectoral heterogeneity in terms of access to finance, which may affect the results concerning β_2 in Eq. (4). To check the robustness of the main results to the BNDES effect, I introduce the interaction term between firm size and sector-level BNDES disbursements in 2010²⁰ ($Lsize_f \times BNDES_s$). Note that, it is found that BNDES loans go particularly to large firms (See Appendix A). These loans can be considered as a form of credit constraints' *relaxation* since they are subsidized funds. Therefore, it is expected to find a positive impact of firm size when coupled with sector-level BNDES disbursements, on exports. The coefficient related to $Lsize_f \times BNDES_s$ is thus expected to be positive²¹. The results displayed in Table 5 confirm this prediction. Larger firms export more in sectors that receive higher BNDES financial support and less in sectors with higher financial needs. While the efficiency of BNDES disbursements has been recently debated (Ottaviano and Souza, 2014), this finding attests of the role of BNDES in helping firms better perform in terms of international trade. However, since the introduction of $Lsize_f \times BNDES_s$ does not affect the significance of the coefficient β_2 , one could think that sector-level BNDES disbursements are *independent* of the level of sector financial vulnerability. This finding suggests that despite the lack of finance in Brazil, Brazilian government support is less likely go to sectors that highly require external finance. Given that the BNDES bank has been created to alleviate financial market failures and to promote industries (Suzigan et al, 2007), the results of this study may suggest the existence of a problem of *targeting* of BNDES public loans.

²⁰The results remain unchanged when I consider BNDES disbursements of 2009.

²¹Since the present study is in cross-section, the sector-level BNDES disbursements are considered to be subsumed in sector fixed effects.

Table 5: Robustness Checks II: BNDES effects

This table presents the estimation results of the main specification using Interval Regression method. Two proxies of firm size are considered. Here, I use Brazilian measures of sector financial vulnerability. I also include control variables: region dummies and wage per worker. An interaction term between firm size and the amount of BNDES disbursements to the sector in which the firm operates is also included. ***, ** and * denote significance at 0.01, 0.05 and 0.1 levels, respectively.

Dep. Var:	Number of employees				Wage Bill			
	1	2	3	4	5	6	7	8
$LEXP_f$ (linf, lsup)	ExtFinBra	ExtFinBra	TangBra	TangBra	ExtFinBra	ExtFinBra	TangBra	TangBra
Lsize f	0.05685 (0.34059)	-0.14654 (0.33012)	0.54855* (0.30502)	0.33895 (0.29569)	0.03988 (0.31333)	-0.08714 (0.30340)	0.45647 (0.28278)	0.30476 (0.27373)
Lsize _{fxFinVuls}	-0.03714*** (0.00989)	-0.03676*** (0.00960)	-0.38995*** (0.13854)	-0.39517*** (0.13438)	-0.03241*** (0.00969)	-0.03114*** (0.00938)	-0.24077* (0.12863)	-0.26824*** (0.12481)
Parent f	-0.79661*** (0.05864)	-0.79661*** (0.05877)	-0.80444*** (0.05877)	-0.80444*** (0.05877)	-0.79596*** (0.05865)	-0.79596*** (0.05865)	-0.80393*** (0.05878)	-0.80393*** (0.05878)
Exp09 f	1.75716*** (0.09699)	1.75716*** (0.09699)	1.75591*** (0.09717)	1.75591*** (0.09717)	1.75499*** (0.09696)	1.75499*** (0.09696)	1.75537*** (0.09711)	1.75537*** (0.09711)
Lwage f	1.28769*** (0.04936)	1.14635*** (0.04835)	1.28383*** (0.04942)	1.14163*** (0.04838)	0.40014*** (0.05260)	0.34583*** (0.05148)	0.38858*** (0.05253)	0.33464*** (0.05140)
Lsize _{fxbndes10s}	0.03721** (0.01557)	0.04261*** (0.01509)	0.02197 (0.01453)	0.02771** (0.01407)	0.03824*** (0.01432)	0.04014*** (0.01387)	0.02392* (0.01343)	0.02734** (0.01299)
Constant	0.12763 (0.44152)	0.70835 (0.44405)	-0.44523 (0.44894)	0.14900 (0.45065)	0.91883 (0.56016)	1.48706*** (0.55558)	-0.24870 (0.55645)	0.31660 (0.55182)
Observations	12,273	12,273	12,273	12,273	12,273	12,273	12,273	12,273
Sector FE	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Log Likelihood	-8059	-7787	-8063	-7790	-8060	-7788	-8064	-7791
Chi2	5402	5947	5395	5940	5400	5944	5392	5937
Sigma	1.926	1.854	1.930	1.857	1.926	1.854	1.929	1.857

Ordered Probit Interval regression method fits the characteristics of the main dependent variable in this study, provided in intervals. These intervals could be however coded into classes of exports. This allows to estimate an ordered probit model. As claimed by Conroy (2005), while less efficient than interval regression method, the estimation of ordered probit model permits to 1) validate the results provided by interval regression, and 2) verify the normality assumption of interval regression method. Given that, I estimate the augmented²² Eq. (4) by considering $P(ExportClass_j | Observed\ variables)_f$ as dependent variable. While one cannot directly interpret Ordered Probit coefficients²³, the results displayed in Appendix F show that the main findings remain unchanged when compared with those in Table 3²⁴. This finding confirms the efficiency of interval regression method.

Firm Size Classifications As robustness checks, I consider different firm size classifications. This permits to capture if there is a non-linear effect of firm size on export performances, across sectors with different levels of external finance dependence. First, I follow the classification of the IBGE (*ClassificationIBGE*) and consider four firm size classes: Small (*S*) for firms with a number of workers inferior to 20, Medium (*M*) for those with a number of workers inferior to 100, Large (*L*) for those having less than 500 workers and finally, Very Large (*VL*) for the remaining firms. I then consider the classification of ORBIS database which divides firms according to four size proxies: the number of employees, total revenues, total assets and the fact the firm is listed or not. This classification (*ClassificationORBIS*) is presented in Appendix B. Considering one classification at a time, I estimate the following Eq. (7):

$$\{LInf_f, LSup_f\} = \beta_0 + \beta_1.M_f + \beta_2.L_f + \beta_3.VL_f + \beta_4.M_f \times FinVul_s + \beta_5.L_f \times FinVul_s + \beta_6.VL_f \times FinVul_s + \beta_7.Parent_f + \beta_8.Exp09_f + \varphi_s + \varepsilon_f \quad (7)$$

where Small firms (*S*) are considered as reference firms. The results using both classifications are presented in Table 6. Larger firms do have better performances in terms of exports. The advantage related to firm size is however found to decrease when the firms operate in sectors that highly depend on external finance. This negative effect seems to be particularly marked for Large firms (*L*). The coefficients related to Very Large (*VL*) firms are globally less important and not usually precisely estimated. This result may be explained by the fact that very large firms are generally Brazilian firms with public participation such as Petrobras, or multinational firms. In both cases, these firms are less credit constrained and their export performances are then *less sensitive* to the general financial constraints of the sector in which they operate. In line with this idea, Manova et al (2011) find, through the analysis of Chinese exports, that multinational firms are more export performant than domestic firms, especially in sectors with high financial needs. This result can corroborate the findings of this present

²²i.e. in which I include control variables presented above.

²³In order to get the right effects, one need to compute *marginal* effects.

²⁴The signs and the significance levels of the coefficients remain the same using interval regression and ordered probit estimations.

study.

I then use *ClassificationORBIS* and estimate the effects of financial constraints on export performances in Brazil, based on an *alternative* sample of Brazilian exporters in 2010²⁵ (See Appendix G). I consider two groups of firms: Large firms which correspond to those in groups (L, VL) and Small & Medium firms which correspond to those in groups (S, M). The results are displayed in Appendix Tables G.2 and G.2, and are consistent with the main findings of the present study. To summarize, the results remain globally robust to different firm size measures considered and different firm size classifications.

²⁵based on ORBIS data availability.

6.2.2 Additional Evidence

In this paragraph, I provide further evidence about the effects of financial constraints on export performances of Brazilian exporters in 2010, by exploring the heterogeneity of exporting firms in terms of their legal status, as well as the region heterogeneity in terms of access to finance.

Main vs. Affiliated I estimate the following Eq. (8) on two sub-samples of firms: Parent companies which are the main (first) establishments in Brazil, and Affiliated companies which are secondary establishments:

$$\{LInf_f, LSup_f\} = \beta_0 + \beta_1.Lsize_f + \beta_2.Lsize_f \times FinVul_s + \beta_3.Lwage_f + \beta_4.Exp09_f + \varphi_s + \varepsilon_f \quad (8)$$

The results using the main measure of firm size $Lemployees_f$ are displayed in Table 7. Considering both sub-samples of firms, larger firms tend to be more export performant. However, some differences arise when focusing on the advantage related to firm size in financially vulnerable sectors. While large Main establishments perform less when they operate in Brazilian sectors with high reliance on external finance, the advantage related to firm size is stressed when focusing on Secondary establishments. It seems then that the main results of this paper are mainly driven by the behavior of Parent firms. Focusing on affiliated firms, larger firms perform more in terms of exports when operating in sectors that highly rely on external finance/ have better access to finance. This result suggests that the firm size would constitute a source of advantage with regards to the access to capital. Affiliated firms are in principal firms that lack of decision-making power, compared with Parent companies. As familiar in the field of Management, strategic decisions are generally taken by headquarters which are likely to be Parent companies. These firms are also more likely to have a bargaining power, when it comes to the relation with the financial sector. If we set this advantage apart²⁶, the size would reappear as a determinant variable with regards to the access to finance. Larger firms are more likely to be privileged by the financiers, especially given the Brazilian context of financial underdevelopment. Considering only Parent companies however, the advantage related to firm size is found to be reduced when the Parent company operates in a sector with high reliance on outside capital. A possible explanation would be that in sectors that depend more on external finance, Parent companies would be more incited to circumvent the financing constraints by creating affiliated firms which will benefit from tax and financial advantages, rather than expanding their exports themselves. This reasoning seems to be suitable to the characteristics of the sample in this study, since Affiliated exporters are found to be larger than Parent exporting companies (Table 2).

²⁶This is the case when only focusing on the group of affiliated (Secondary) establishments.

Table 7: Firm size and Firm exports: Does the Legal Status matter?

In this table, I present the estimation results of the main specification on two subsamples of companies: Main establishments and Affiliated firms. Interval Regression method is used. ***, ** and * denote significance at 0.01, 0.05 and 0.1 levels, respectively.

Dep. Var:	Main							
	Affiliated				Main			
LEXP _{<i>f</i>} (linf, lsup)	ExtFinBra	TangBra	ExtFinBra	TangBra	ExtFinBra	TangBra	ExtFinBra	TangBra
	1	2	3	4	5	6	7	8
Lemployees _{<i>f</i>}	0.76068*** (0.03894)	0.76278*** (0.03802)	0.55706*** (0.11266)	0.61185*** (0.11020)	0.86811*** (0.02354)	0.78587*** (0.02269)	0.96131*** (0.05543)	0.93748*** (0.05343)
Lemployees _{<i>f</i>} xFinVul _{<i>s</i>}	0.03627* (0.02018)	0.03239* (0.01948)	0.51025* (0.29749)	0.36951 (0.29044)	-0.02005** (0.01001)	-0.03632*** (0.00975)	-0.23006 (0.15234)	-0.36178** (0.14751)
Exp09 _{<i>f</i>}	1.75179*** (0.17129)	1.60432*** (0.16526)	1.75363*** (0.17117)	1.60757*** (0.16524)	2.01177*** (0.12861)	1.86055*** (0.12499)	2.01152*** (0.12868)	1.86051*** (0.12508)
Lwage _{<i>f</i>}	1.08672*** (0.10332)	1.08672*** (0.10332)	1.08316*** (0.10342)	1.08316*** (0.10342)	1.14459*** (0.05471)	1.14459*** (0.05471)	1.3537*** (0.05458)	1.3537*** (0.05458)
Constant	9.11988*** (0.51979)	1.48292 (0.90252)	9.74773*** (0.57741)	1.99091** (0.94927)	6.70874*** (0.30151)	-0.85095* (0.49336)	6.44233*** (0.32016)	-1.23787** (0.51392)
Observations	2,074	2,059	2,074	2,059	10,269	10,214	10,269	10,214
Sector FE	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Region FE	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Log Likelihood	-2331	-2264	-2331	-2265	-5738	-5457	-5739	-5461
Chi2	830.2	934.6	829.9	933.4	3667	4155	3665	4146
Sigma	2.103	2.016	2.102	2.017	1.871	1.761	1.872	1.764

Southeast vs. Less Developed Regions Here, I pay particular attention the regional effect in terms of access to finance. There exists, in fact, a regional inequality in Brazil in terms of financial endowments. Lima and Resende (2008) argue that richer regions (notably Southeast) are better endowed of private banks and that the situation reverses when focusing on public banks. Crocco et al (2014) stress however the gap in terms of credit availability between the Southeast²⁷ and the other regions. Based on this finding, I consider two groups of firms: those established in the region of the Southeast, and those established in other regions. Considering that credit is more available in the Southeast, one would expect that the size advantage would lose of its importance when Southeast firms operate in sectors that can rely on external finance/ have better access to finance (high levels of $ExtFinBra_s$).

The results presented in Table 8 confirm that large firms are more export performant compared with smaller ones. They show however that the comparative advantage of firm size decreases in sectors with high reliance on outside capital, more for firms operating in the Southeast in comparison with those in other regions. As expected, the firm size advantage decreases when firms operate in sector with easier access to finance especially in regions with capital endowments, here, the Southeast region. For "Other regions", the effects of sector-level financial constraints on the importance of firm size are not precisely estimated. This result can be explained by a couple of ideas. First, in financially less developed regions, the access to credit is considered to be harder compared with the Southeast. In this context, large firms would be favored by the financiers. Large firms are generally assumed to be more performant and more productive and present less risks of default. Their access to credit would then be easier compared with smaller firms. Second, the last decade has been marked with a real effort of the government to improve financing conditions in the less endowed regions notably the North and the Northeast. These efforts are embodied by a number of tax incentives offered by the Development agencies of Northeastern States (*Superintendência de Desenvolvimento do Nordeste*, SUDENE) and of the Amazon (*Superintendência de Desenvolvimento da Amazônia*, SUDAM). The aim of this tax incentive mechanism is to enhance investments in the less developed regions. These incentives could then present *distortions* to the credit availability and access to finance.

²⁷This region includes four states: São Paulo, Rio de Janeiro, Minas Gerais and Espírito Santo.

Table 8: Firm size and Firm exports: Exploring Region Heterogeneity

In this table, I present the estimation results of the main specification on two sub-samples of companies: those operating in Southeast and those operating in other regions: South, North, Northeast and Central West. Interval Regression method is used. ***, ** and * denote significance at 0.01, 0.05 and 0.1 levels, respectively.

Dep. Var:	Other Regions											
	South East						Other Regions					
	Number of Employees		Wage Bill		Number of Employees		Wage Bill		Number of Employees		Wage Bill	
1	2	3	4	5	6	7	8	ExtFinBra	TangBra	ExtFinBra	TangBra	
<i>Lsize_f</i>	0.84796*** (0.02781)	1.10757*** (0.07653)	0.85624*** (0.02764)	1.00283*** (0.07007)	0.72584*** (0.02727)	0.81137*** (0.06181)	0.73249*** (0.02710)	0.80466*** (0.06005)				
<i>Lsize_fxFinVul_s</i>	-0.05989*** (0.01641)	-0.67540*** (0.21108)	-0.04826*** (0.01576)	-0.35919* (0.19008)	-0.02046** (0.01025)	-0.18778 (0.16431)	-0.01487 (0.01019)	-0.16671 (0.15734)				
<i>Parent_f</i>	-0.82694*** (0.08059)	-0.84089*** (0.08070)	-0.82738*** (0.08063)	-0.84165*** (0.08074)	-0.77542*** (0.08549)	-0.77911*** (0.08560)	-0.77538*** (0.08553)	-0.77949*** (0.08564)				
<i>Exp09_f</i>	1.78024*** (0.14129)	1.77292*** (0.14121)	1.77917*** (0.14124)	1.77253*** (0.14104)	1.66552*** (0.13229)	1.66613*** (0.13243)	1.66694*** (0.13235)	1.66772*** (0.13247)				
<i>Lwage_f</i>	1.07921*** (0.06363)	1.07731*** (0.06364)	0.19345*** (0.06883)	0.18200*** (0.06880)	1.23022*** (0.07673)	1.22472*** (0.07666)	0.48037*** (0.07965)	0.47869*** (0.07970)				
Constant	-0.32970 (0.55677)	-1.02150* (0.59325)	-0.04307 (0.56519)	-1.16757* (0.68836)	-0.11711 (0.63878)	-0.32492 (0.65857)	0.00751 (0.64671)	-0.54615 (0.74349)				
Observations	7,272	7,272	7,272	7,272	5,001	5,001	5,001	5,001				
Sector FE	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes				
Log Likelihood	-4255	-4257	-4257	-4260	-3493	-3494	-3494	-3494				
Chi2	3461	3457	3456	3450	2487	2484	2485	2484				
Sigma	1.891	1.894	1.891	1.894	1.800	1.801	1.801	1.801				

7 Firm size and Inherent sector needs of external capital

One contribution of this present study is that I consider measures of sector financial dependence, *specific* to Brazilian industries in the last decade. Instead of representing intersectoral technological differences (Rajan and Zingales, 1998), Brazilian measures reflect rather intersectoral differences after accounting for distortions in the Brazilian market, notably financial ones. Although Brazilian measures are calculated over data on listed companies²⁸ and smoothed over 2000-2012, they can be subject endogeneity issue. Based on Brazilian data, intersectoral differences in terms of dependence on external finance would be *endogenous* to the Brazilian overall level of economic and financial development. Yet, the literature proposes a number of studies where the indicators of sector-level financial needs are computed using data *on* the individuals of the main sample of firms in the study. Bricongne et al (2012) for instance, study the effects of financial constraints of French firms on their exports during the crisis of 2008 and compute measures of sector financial vulnerability using data on the same firms of interest in the study. Similarly, Alfaro (2014) analyzes the effects of capital controls on Brazilian exports and to do so, they compute measures of external finance dependence based on Brazilian data.

That being said, it remains interesting to consider the *inherent* needs of different manufacturing sectors as defined by Rajan and Zingales (1998). Measures of financial vulnerability computed over US data are assumed to capture the needs of manufacturing sectors in terms of outside capital based on their *inherent* technological characteristics. Three indicators of financial vulnerability ($FinVulUS_s$) are considered: the external finance dependence ($ExtFinUS$), R&D intensity ($RDUS$) as well the level of asset tangibility ($TangUS$). The first two measures are supposed to be inversely correlated with asset tangibility measure. I estimate the following Eq. (9) using interval regression method, considering one measure of sector financial constraints at a time:

$$\{LInf_f, LSup_f\} = \beta_0 + \beta_1.Lsize_f + \beta_2.Lsize_f \times FinVulUS_s + \beta_3.Parent_f + \beta_4.Exp09_f + \varphi_s + \varepsilon_f \quad (9)$$

I need also to recall that the main results of this study have shown that large firms perform less in sectors that exhibit easier access to finance in Brazil, as well as those with many tangible assets. As explained, this result could be attributed to the lack of credit in Brazil. In this paragraph, the use of US indicators will therefore permit to check if these results are driven by the endogeneity of Brazilian measures of financial dependence.

7.1 Main Results

In Table 9, I present the estimation results of Eq. (9), considering intersectoral differences in terms of inherent external finance needs. Accounting for the quality of financial institutions

²⁸ Assumed to be less credit constrained.

in the US, US indicators are considered to be *benchmarks*. In line with the main results of this study, Table 9 shows that large firms are more likely to be export performant compared to smaller ones. The importance of firm size in explaining Brazilian firms' exports decreases however in sectors that highly depend on external finance and in those with high R&D intensity. Firm size does not secure better export performances in financially vulnerable sectors. The size advantage is reduced when the firms operate in sectors which are, by their inherent characteristics, dependent on external finance. This result attests of the difficulties that large firms may encounter when operating in sectors with higher needs on external finance. This result can be explained by the Brazilian context characterized by weaknesses of the financial sector. The high cost of external capital and market imperfections result into a problem of credit availability in the Brazilian market. This is likely to more affect firms that operate in sectors that are more dependent on external finance. Even large firms do encounter problems in the access to credit, which impedes their export performances. Similar results are found when considering the measure (*TangUS*). The advantage of being a large firm, with regards to export performances, is reduced when firms operate in industries with many tangible assets. This result suggests that for these sectors, the access to credit does not heavily rely on the size of the firm. Firms in these sectors have less financial problems when demanding financial support from the banking sector, since they have the ability to present their hard assets as collaterals.

To summarize, while the firm size is considered as a good predictor of export performances for Brazilian firms, the role of firm size in enhancing the export activity decreases when considering the financial constraints at sector-level. Even though large firms are less likely to be credit constrained, requiring external funds to finance the export activity (fixed and variable costs) makes them less performant when operating in sectors that highly rely on external capital. This finding can be attributed to the underdeveloped Brazilian financial system. Despite the waves of reforms over the last decades, Brazilian firms suffer from a lack of credit that hampers their investments, notably their activity in the foreign market. While the use of Brazilian data-based indicators of financial vulnerability could drive an endogenous effect to the link between firm size and firm performances, the results of this section confirm the effects of sector-level financial dependence on export performances of Brazilian large exporters.

Table 9: Firm Size, Sector Inherent Financial needs and Firm Exports

This table presents the estimation results of the main specification using Interval Regression method. Here, I consider US indicators of sector financial vulnerability proposed by Kroszner et al (2007). Firm size is proxied with the number of employees. ***, ** and * denote significance at 0.01, 0.05 and 0.1 levels, respectively.

Dep. Var:	ExtFinUS			RDUS				TangUS			
	1	2	3	4	5	6	7	8	9		
LEXP _{<i>f</i>} (lnf, lsup)											
Lemployees _{<i>f</i>}	0.95661*** (0.02432)	0.85032*** (0.02347)	0.81329*** (0.02292)	0.98038*** (0.02561)	0.87211*** (0.02474)	0.83772*** (0.02418)	1.27645*** (0.09351)	1.12132*** (0.09059)	1.00918*** (0.08876)		
Lemployees _{<i>f</i>} xFinVulUS _{<i>s</i>}	-0.15395*** (0.04739)	-0.14149*** (0.04609)	-0.17685*** (0.04446)	-0.74969*** (0.23108)	-0.68602*** (0.22516)	-0.76037*** (0.21691)	-1.09722*** (0.30644)	-0.93035*** (0.29756)	-0.67267*** (0.29232)		
Parent _{<i>f</i>}		-0.92469*** (0.07743)	-0.83091*** (0.07458)		-0.92234*** (0.07747)	-0.82953*** (0.07465)		-0.93533*** (0.07771)	-0.84368*** (0.07486)		
Exp09 _{<i>f</i>}		1.97754*** (0.12925)	1.84052*** (0.12532)		1.98021*** (0.12930)	1.84451*** (0.12540)		1.97714*** (0.12988)	1.84326*** (0.12591)		
Lwage _{<i>f</i>}			0.97545*** (0.05858)			0.96832*** (0.05856)			0.96729*** (0.05890)		
Constant	10.57994*** (0.60578)	9.95918*** (0.60505)	2.80280*** (0.73804)	10.76085*** (0.65713)	10.11336*** (0.65360)	2.79017*** (0.78594)	7.98984*** (0.31509)	7.63483*** (0.33525)	0.27997 (0.58438)		
Observations	8,090	8,090	8,037	8,090	8,090	8,037	8,090	8,090	8,037		
Sector FE	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes		
Log Likelihood	-5391	-5184	-4991	-5391	-5184	-4993	-5390	-5183	-4996		
Chi2	3086	3501	3811	3086	3501	3808	3089	3502	3801		
Sigma	2.045	1.956	1.869	2.046	1.957	1.870	2.055	1.964	1.878		

7.2 Any crisis effect ?

This study focuses on the export performances of Brazilian exporters in 2010, two years after the financial crisis of 2008. In this paragraph, I explore the effects of this recent crisis on the role of financial constraints in explaining export performances. The recent financial crisis has led to a worldwide credit tightening. Considering this effect, the importance of financial constraints at firm- and sector- levels would be reinforced by the widespread problems of financing caused by the crisis. This question would be particularly interesting for the Brazilian case since the Brazilian government has implemented capital controls in order to limit the crisis effects. These controls are found to increase the cost of capital in the Brazilian market and to negatively affect firms' investments (Alfaro, 2014). In order to check the importance of credit tightening in the aftermath of the crisis, I estimate Eq. (9) using data on Brazilian exporters in 2009. The results in Table 10 show two different results, depending on the use of Brazilian measures of sector financial vulnerability or US benchmarks. Beginning with the *inherent* financial needs of manufacturing sectors, the results remain unchanged when considering the crisis effect. The importance of firm size in explaining trade decreases when accounting for technological-based financial constraints at sector-level. These results would be explained by the fact that US indicators are meant to only reflect intersectoral *technological* differences that are not likely to be affected by the crisis. Less precise effects of the crisis are however found when considering Brazilian measures of sector-level financial constraints. Results show that there is no evidence of a change in the importance of the firm size during the crisis, with regards to export performances when the firm operates in a sector that has easier access to finance, given the Brazilian context. This result suggests that during the crisis, being a large firm presents a good element in favor of higher export performances, independent of the sector of activity in which the firm operates. An alternative explanation would be behind these results. In the context of external funds shortage, large firms can be considered as less credit constraints compared with other firms, since these firms can make use of their abundant internal funds. Consistent with the literature on finance and investments, firms have to arbitrate between external and internal sources of funding. These explanations are consistent with the findings of Alfaro et al (2014), which suggest a less negative effect of Brazilian capital controls on the export performances of large Brazilian firms.

Overall, the financial crisis of 2008 does not seem to affect behaviours of Brazilian exporters in sectors with high *inherent* financial needs. The results show however that this crisis would have affected the financial conditions in Brazil. In this context, firm size regains importance with reference to export performances' explanation.

Table 10: Firm size and Firm Exports in 2009: Is there any Crisis Effect?

This table presents the estimation results of the main specification using Interval Regression method, for the year 2009. I consider Brazilian measures of financial vulnerability as well as US indicators proposed by Kroszner et al (2007). Firm size is proxied with the number of employees. ***, ** and * denote significance at 0.01, 0.05 and 0.1 levels, respectively.

Dep. Var:	ExtFinBra		TangBra		ExtFinUS		RDUS		TangUS	
LEXP _f (linf, lsup)	1	2	3	4	5	6	7	8	9	10
Lemployees _f	0.80021*** (0.02380)	0.73772*** (0.02278)	0.80793*** (0.05673)	0.76180*** (0.05465)	0.78832*** (0.02695)	0.74051*** (0.02580)	0.80760*** (0.02837)	0.77659*** (0.02750)	1.19364*** (0.10753)	0.93941*** (0.10397)
Lemployees _f FinVul _s	0.01234 (0.00988)	0.00233 (0.00963)	-0.05300 (0.15203)	-0.07588 (0.14629)	-0.10552** (0.05216)	-0.17665*** (0.05069)	-0.46990* (0.26061)	-0.62776** (0.25993)	-1.37798*** (0.34979)	-0.66832** (0.33923)
Parent _f	-0.99681*** (0.07208)	-0.74962*** (0.06890)	-0.99855*** (0.07221)	-0.75140*** (0.06900)	-0.92272*** (0.08991)	-0.74358*** (0.08563)	-0.94179*** (0.08966)	-0.80264*** (0.08627)	-0.94307*** (0.09024)	-0.76295*** (0.08596)
Exp08 _f	1.56612*** (0.12411)	1.48413*** (0.11954)	1.56812*** (0.12428)	1.48578*** (0.11964)	1.68544*** (0.15641)	1.62503*** (0.15164)	1.67594*** (0.15536)	1.63648*** (0.15151)	1.69091*** (0.15710)	1.62453*** (0.15202)
Lwage _f	1.24206*** (0.05764)	1.24206*** (0.05764)	1.24206*** (0.05764)	1.24206*** (0.05763)	1.30289*** (0.07310)	1.30289*** (0.07310)	1.30289*** (0.07310)	1.07955*** (0.06940)	1.07955*** (0.06940)	1.27384*** (0.07340)
Constant	9.00206*** (0.27033)	0.41781 (0.49852)	9.02258*** (0.28949)	0.36510 (0.51148)	10.87793*** (0.71947)	1.83289** (0.87423)	10.41824*** (0.77871)	2.36720** (0.94118)	8.62993*** (0.41747)	-0.61989 (0.70213)
Observations	7,760	7,742	7,760	7,742	5,062	5,049	5,062	5,049	5,062	5,049
Sector FE	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Region FE	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Log Likelihood	-5397	-5139	-5398	-5139	-3421	-3246	-3434	-3300	-3415	-3250
Chi2	3280	3760	3278	3760	2244	2568	2218	2460	2255	2560
Sigma	1.854	1.742	1.855	1.742	1.812	1.700	1.816	1.729	1.819	1.708

8 Conclusion

This paper places itself in the growing literature on the impact of financial frictions on trade patterns. The aim of this paper is particularly to provide micro-level evidence on the role of financial constraints at firm- and industry- levels in explaining export performances in Brazil. The focus on the Brazilian case is motivated by the fact that Brazil has not exploited its potential of international trade (Canuto et al, 2013) and by the problems in credit availability that make financial constraints persist in Brazil, despite the continuous public efforts to enhance the efficiency of the financial system.

This study contributes to the field of international trade by at least two elements. To begin with, this paper exploits the Interval Regression method of estimation (Conroy, 2005). To my knowledge, this method has never been used in the field of international trade. Interval Regression method allows to estimate the export performances when data is censored, here provided in ranges of exports. The second contribution of this paper is the use of Brazilian measures to proxy the external financial needs of Brazilian manufacturing industries. The indicators better assess the *specific* financial conditions of Brazilian industries, compared with US indicators that have been widely used in the literature. Indeed, these measures capture the effects of the low development of the Brazilian financial system on the allocation of capital between manufacturing sectors and on their *access* to finance, by consequence.

The findings of this paper provide strong evidence that larger firms are more likely to be export performant, and that the advantage related to firm size decreases however when accounting for the financial needs of the manufacturing sectors in which they operate. Using Brazilian sector-level indicators, I find that the importance of firm size is reduced in sectors that present high levels of dependence on external finance and in those with many tangible assets, as well. This result is in contrast with the traditional predictions in the literature. In fact, the dependence on external finance is supposed to be inversely correlated with the level of asset tangibility. Therefore, one would predict that the effects of these two sector-measures, on the advantage related to firm size, are in opposite signs. Considering Brazilian characteristics, this result can be explained. In fact, due to the problems in credit availability, sectors that highly depend on external finance are those that present many tangible assets. In other words, only industries that can provide collaterals when demanding credit are able to rely on external capital. Due to financial market imperfections, sectors with few tangible assets find it better to search for alternative sources of funding, different from funds from the banking system. This idea can be supported by the results of the Brazilian Investment Climate Survey, which suggest that 67% of loans proposed to Brazilian firms require collaterals (Kumar and Francisco, 2005). Another explanation can be provided. In sectors with high needs in terms of external capital, even large firms would be negatively affected. Due to their size, these firms are by nature in need of more external finance compared with smaller ones. Taking into account the high cost of capital, large firms would be brought to search for other sources of financing, notably internal funds. This idea is also supported by the results of

the survey mentioned above. 32% of large firms declare not applying for loans due to the high interest rates (against 36.5, 33.2 and 33% for micro, small and medium-sized firms). Considering the intersectoral differences in terms of *inherent* needs of external finance, the main finding is that the size advantage of large firms decreases when exporting firms operate in sectors that highly depend on external finance. Once again, this result can be justified by the imperfections of the Brazilian financial sector.

Additional results suggest that main establishments perform less compared with affiliated firms. This finding is consistent with Brazilian tax incentives to promote exports. As said before, it is for example more interesting for a company to export through an affiliated firm in the Brazilian Export Processing Zone (EPZ), rather than exporting itself the goods. Further estimations show that large firms present higher export performances when they operate in sectors that have received higher BNDES loans in 2010. This finding attests of the export promotion effects of these public loans. It shows also that BNDES loans may distort the financial needs and access to finance of different manufacturing sectors.

Given all these elements, this paper has a number of policy implications. First, as suggested by this study, large firms do face constraints when financing their investments. The high cost of capital and the low quality of legal frameworks hamper Brazilian firms' activities. Therefore, additional efforts by the Brazilian government would be needed to improve the efficiency of financial intermediation. In this regard, the results suggest that BNDES loans would be a form of credit relaxation when exporting. Thus, a possible policy would be to target sectors that are *by nature* reliant on external finance. Recall that the Brazilian government has created the BNDES bank in order to enhance the development of the economy and the industrial production (Suzigan et al, 2007), among other objectives. In this context, this paper suggests that more actions are needed to ensure the growth of the industrial sector, notably in terms of financial support. Given that BNDES loans particularly go to large firms and to manufacturing sectors, it seems that the problem with BNDES loans is mainly an *efficiency* issue (Lazzarini et al, 2015).

Focusing on trade, the present study confirms that financial market imperfections hamper international trade performances. This finding may explain the relatively low performances of Brazil in terms of manufacturing exports. Given the resource endowments of Brazil and the international fragmentation of the production system, public policies can be called to help the economy better exploit its export potential in the manufacturing sector. By checking the Brazilian history, one can notice that inflation rates remain high, which leads to a high cost of capital. In the absence of remedy to high inflation, well targeted subsidized credits²⁹ and tax incentives would be part of the solution, to expand exports. Note that the low performances of Brazil in terms of exports can also demonstrate of a Brazilian *culture* oriented towards domestic consumption, given the size of the Brazilian market. The consumption in Brazil does however only represent 4% of the world demand. This would be an additional factor

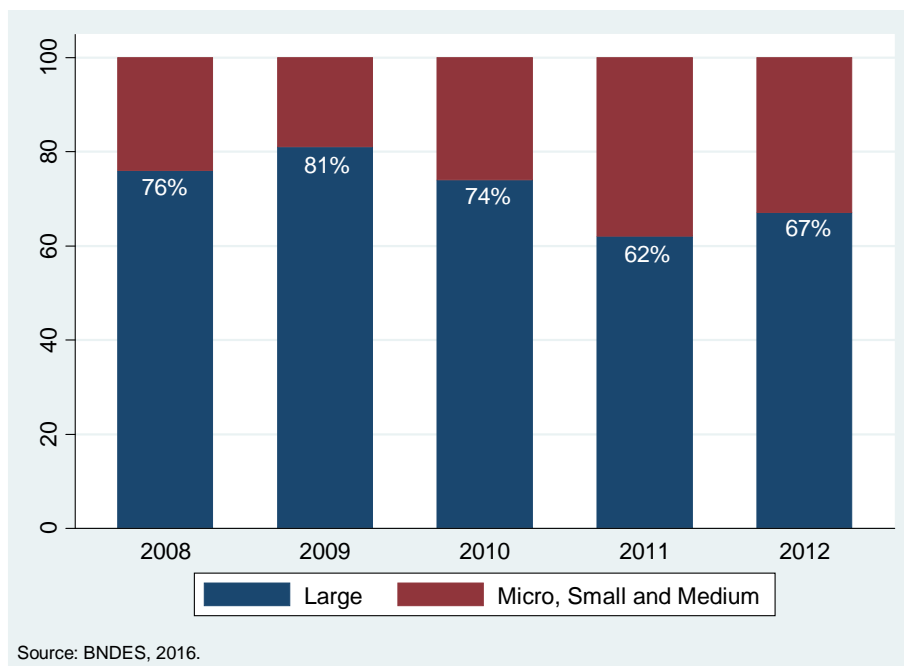
²⁹In fact, BNDES subsidized credit mainly go for firms that have higher capacities to repay loans, rather than those in higher needs of financial support.

that boosts the Brazilian government to act in favor of a facilitation of the exporting activity, in order to ensure high levels of economic development.

Finally, further researches are needed in order to confirm the findings of this present work. First, while the method of estimation in this paper presents a contribution to the field of international trade, the use of exact values of exports would be more precise. Second, it would be interesting to have information about the ownership of exporting firms. Multinational companies for example are found to be less credit constrained compared with domestic companies (Manova et al, 2011). It would be then interesting to control for firm ownership when studying the effects of financial constraints at firm-level. This question is even more important with regards to trade given the increasing role of multinational companies in determining international trade patterns. In addition, since the financial crisis has resulted in a worldwide credit shortage, further research is needed to disentangle the effects of the financial crisis from those related to the domestic financial market's imperfections, when explaining firms' export performances. This idea is relevant for the Brazilian case since the Brazilian government has implemented, as in some other emerging markets, capital controls in the aftermath of the crisis, resulting in an increase in the cost of capital (Alfaro et al, 2014). Finally, it would be also interesting to go deeper into the study the effects of precise *export incentives* on Brazilian firms' export performances. While the efficiency of BNDES loans has been treated in the literature (Ottaviano and Souza, 2007; 2014), there are no works that focus on the effects of BNDES loans *specific* to the exporting activity on Brazilian firms' export performances. The study of these Brazilian characteristics can be even more motivated by the current crisis episode that Brazil is facing since 2014.

Appendix

A BNDES Disbursements



Appendix Figure A: BNDES disbursements by class of firm size (in %)

B Firm Size Indicators -ORBIS

This table presents the classification of firm size provided by ORBIS database (Accessed in 2012).

Size	Operating Revenue	Total Assets	Employees	Other
VL	>= 130 million US \$	>= 260 million US \$	>=1000	Listed
L	>= 13 million US \$	>= 26 million US \$	>=150	Not VL
M	>= 1.3 million US \$	>= 2.6 million US \$	>=15	Not L, VL
S	Firms not included in other categories			

C Measures of Sector-Level Financial Vulnerability

Table C.1 Brazilian measures of Financial Vulnerability

In this table, I display two measures of financial vulnerability computed using Brazilian data over 2000-2012. ExtFinBra is the median value of capital expenditures that are not financed with internal funds, as proposed by RZ. TangBra informs about the part of tangible assets in total assets.

CNAE 2.0	Industry	ExtFinBra	TangBra
30	Other transport equipment	-6,94	0.11
15	Leather and Footwear	-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 Publishing	-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	Drugs	1,99	0.17

Table C.2 US measures of Financial Vulnerability (Kroszner et al, 2007)

ISIC CODE	Industry	ExtFinUS	RDUS	TangUS
314	Tobacco	-1,14	0,00	0,19
361	Pottery	-0,41	0,02	0,28
323	Leather	-0,95	0,01	0,12
3211	Spinning	-0,05	0,01	0,38
324	Footwear	-0,74	0,01	0,13
372	Non-ferrous metal	-0,12	0,01	0,32
322	Apparel	-0,21	0,00	0,15
353	Refineries	-0,02	0,00	0,62
369	Non metal products	-0,29	0,01	0,48
313	Beverages	0,03	0,00	0,40
371	Iron and Steel	0,05	0,01	0,44
311	Food products	-0,15	0,01	0,37
3411	Pulp and Paper	-0,07	0,01	0,60
3513	Synthetic resins	0,03	0,03	0,40
341	Paper products	-0,35	0,01	0,42
342	Printing and Publishing	-0,42	0,01	0,21
352	Other Chemical products	-0,30	0,02	0,27
355	Rubber products	-0,02	0,02	0,36
332	Furniture	-0,38	0,01	0,28
381	Metal Products	-0,25	0,01	0,28
3511	Basic chemicals	-0,19	0,03	0,43
331	Wood products	0,05	0,01	0,32
384	Transport Equipment	-0,08	0,02	0,23
354	Petroleum and coal	0,13	0,01	0,46
3843	Motor vehicles	0,06	0,02	0,28
321	Textiles	0,01	0,01	0,31
382	Machinery	-0,04	0,02	0,22
3841	Ship Building	0,38	0,02	0,28
390	Other manufacturing	0,28	0,02	0,18
362	Glass	0,03	0,02	0,42
383	Electrical machinery	0,24	0,07	0,21
385	Professional equipment	0,72	0,09	0,16
3832	Radio	0,70	0,09	0,14
3825	Office and computing	0,54	0,10	0,14
356	Plastic products	-0,02	0,02	0,38
3522	Drugs	2,43	0,58	0,16

D Descriptive Statistics

Table D.1 Sector composition of Exporting Firms in 2010

CNAE Class	Industry	% of firms
10	Food Products	9.36
11	Beverages	0.80
12	Tobacco	0.31
13	Textiles	3.53
14	Apparel	4.87
15	Leather and Footwear	5.42
16	Wood products	4.20
17	Paper and products	1.84
18	Printing and Publishing	0.67
19	Petroleum and Coal products	0.59
20	Chemicals	8.34
21	Drugs	1.38
22	Rubber and Plastic products	7.99
23	Non-metallic mineral products	4.02
24	Iron and Steel	2.99
25	Metal products	6.08
26	Computer, Electronic and Optical	4.45
27	Electrical machinery	4.43
28	Machinery	13.81
29	Motor vehicles	5.93
30	Other transport equipment	0.69
31	Furniture	2.99
32	Other manufacturing	5.32
	Total	100.00

Table D.2 Summary statistics

Variable	Nb. Obs.	Mean	Std. Dev.	Min	Max
linf	3729	14.75088	1.462138	13.81551	18.42068
lsup	12361	14.61398	1.331433	13.81551	18.42068
Number of Employees	12556	216.9817	582.1265	0	19247
Wage Bill	12556	508591.5	1836623	0	8.16e+07
Wage Per Worker	12343	2191.312	8895.562	0	945551.5
Parent	12556	.829245	.3763097	0	1
bndes10	12556	3.18e+09	3.86e+09	4924120	2.87e+10

Table D.3 Firm Size and Dependence on External Finance

This table displays the mean values of variables of firm size considering the level of dependence on external finance of the sector in which firms operate. Two categories are considered: sectors with Low Dependence ($\text{ExtFinUS} < 0$) and those with High Dependence ($\text{ExtFinUS} > 0$).

Variable	Low Dep.	High Dep.
Number of Employees	207.8308	223.0612
Wage Bill	414439.5	571143.2
Wage Per Worker	2072.206	2270.31
Nb. Obs.	5012	7544

Table D.4 Export Behavior of the Survivors in 2010

Status in 2010	Number of firms
$\text{ExportRange10} > \text{ExportRange9}$	829
$\text{ExportRange10} = \text{ExportRange9}$	9069
$\text{ExportRange10} < \text{ExportRange9}$	516
Total	10414

E Wage Bill, Sector Financial Vulnerability and Firm Exports

In this table, I display the estimation results of Eq. (2.1) using the wage bill as a measure of firm size. In order to capture sector-level financial vulnerability, I use Brazilian measures computed over the 2000s. The estimation is based on Interval Regression method. ***, ** and * denote significance at 0.01, 0.05 and 0.1 levels, respectively.

Table E.1 Using the wage bill as a proxy of firm size

Dep. Var:	ExtFinBra		TangBra					
LEXP _{<i>f</i>} (limf, lsup)	1	2	3	4	5	6	7	8
Lwageb _{<i>f</i>}	0.92611*** (0.01867)	0.87716*** (0.01852)	0.87716*** (0.01852)	0.82778*** (0.01816)	1.01739*** (0.04658)	0.98629*** (0.04587)	0.98629*** (0.04587)	0.93067*** (0.04518)
Lwageb _{<i>f</i>} xFinVul _{<i>s</i>}	-0.02354*** (0.00879)	-0.02197** (0.00863)	-0.02197** (0.00863)	-0.02195*** (0.00850)	-0.21840* (0.12491)	-0.27511** (0.12307)	-0.27511** (0.12307)	-0.25608** (0.12133)
Parent _{<i>f</i>}		-0.76570*** (0.05956)	-0.76570*** (0.05956)	-0.85495*** (0.05909)	-0.77282*** (0.05964)	-0.77282*** (0.05964)	-0.77282*** (0.05964)	-0.86151*** (0.05917)
Exp09 _{<i>f</i>}				1.76008*** (0.09744)				1.76033*** (0.09751)
Constant	1.56192*** (0.27179)	2.83750*** (0.27846)	2.83750*** (0.27846)	1.88800*** (0.28847)	0.82188** (0.37113)	2.00777*** (0.37169)	2.00777*** (0.37169)	1.09448*** (0.37808)
Observations	12,294	12,294	12,294	12,294	12,294	12,294	12,294	12,294
Sector FE	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Log Likelihood	-8160	-8078	-8078	-7878	-8162	-8079	-8079	-7879
Chi2	5228	5392	5392	5792	5224	5390	5390	5789
Sigma	1.958	1.927	1.927	1.882	1.960	1.928	1.928	1.884

F Robustness Checks: Ordered Probit

In this Table, I present the estimation results of Eq. (1) using Ordered Probit model. Note that the coefficients displayed cannot be directly interpreted. One should compute marginal effects. However, these coefficients can inform the reader about the sign and the significance of the effects. Here, firm size is proxied with the number of employees. In order to capture sector level financial constraints, I use Brazilian measures computed over the 2000s. ***,** and * denote significance at 0.01, 0.05 and 0.1 levels, respectively.

Table F.1 Ordered Probit results

Dep. Var: LEXP _f (linf, lsup)	ExtFinBra			TangBra		
	1	2	3	4	5	6
Lemployees _f	0.46559*** (0.00982)	0.44576*** (0.00992)	0.42949*** (0.01007)	0.51208*** (0.02439)	0.50423*** (0.02442)	0.48487*** (0.02472)
Lemployees _f xFinVul _s	-0.00797* (0.00443)	-0.00796* (0.00443)	-0.00831* (0.00448)	-0.11920* (0.06685)	-0.15515** (0.06689)	-0.14471** (0.06758)
Parent _f		-0.45809*** (0.03056)	-0.51223*** (0.03103)		-0.46060*** (0.03057)	-0.51448*** (0.03104)
Exp09 _f			0.96615*** (0.05030)			0.96580*** (0.05033)
Constant cut1	2.78106*** (0.07661)	2.28667*** (0.08338)	3.06822*** (0.09548)	2.90309*** (0.08905)	2.43176*** (0.09458)	3.20811*** (0.10581)
Constant cut2	3.86750*** (0.08051)	3.39518*** (0.08652)	4.20989*** (0.09903)	3.98912*** (0.09238)	3.53987*** (0.09733)	4.34933*** (0.10899)
Constant cut3	4.69088*** (0.08572)	4.23871*** (0.09105)	5.06766*** (0.10348)	4.81192*** (0.09668)	4.38262*** (0.10116)	5.20647*** (0.11284)
Constant cut4	5.07564*** (0.08959)	4.63207*** (0.09464)	5.46499*** (0.10679)	5.19629*** (0.10004)	4.77551*** (0.10432)	5.60337*** (0.11583)
Observations	12,343	12,343	12,343	12,343	12,343	12,343
Sector FE	Yes	Yes	Yes	Yes	Yes	Yes
Region FE	No	No	No	No	No	No
Log Likelihood	-8487	-8376	-8152	-8487	-8375	-8152
Chi2	4636	4858	5305	4636	4860	5306

G Robustness Checks: Alternative Sample

As robustness check, I present the estimation results based on an alternative sample of exporting firms in 2010. This sample is got by matching data on exports with data on firm size from the ORBIS database. Two categories of firm size are considered: Large firms are those in Large and Very Large classes according to ORBIS classification and other firms (Small and Medium firms). Details of the classification are presented in Appendix 2.1. Appendix Table 2.7.1 presents descriptive statistics of the database. The following tables present Interval Regression results using Brazilian measures of financial vulnerability: ExtFinBra and TangBra. ***,** and * denote significance at 0.01, 0.05 and 0.1 levels, respectively.

Table G.1 Descriptive Statistics

Interval of Exports in million US\$	Legal Status		Export Status	
	Affiliated	Main	New Exporters	Survivors
Exp < 1	860	6427	1831	5456
1 < Exp < 10	555	1421	98	1878
10 < Exp < 50	324	366	34	656
50 < Exp < 100	82	66	2	146
Exp > 100	105	60	17	148
Nb. Obs.	1926	8340	1982	8284

Table G.2 ORBIS Firm Size, Dependence on External Finance and Firm Exports

Dep. Var:	1	2	3	4	5	6	7
LEXP _f (linf, lsup)							
L _f	1.707***	1.709***	1.461***	2.773***	2.771***	2.537***	2.535***
L _f xExtFinBra _s	-0.107**	-0.096**	-0.068*	-0.047	-0.036	-0.023	-0.011*
Exp09 _f			2.264***			2.112***	2.118***
Parent _f				-2.968***	-2.960***	-2.907***	-2.897***
Constant	12.437***	12.386***	10.505***	14.184***	14.149***	12.381***	12.332***
Controls:				Sector F.E.			
Region FE	No	Yes	Yes	No	Yes	No	Yes
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

Table G.3 ORBIS Firm Size, Asset Tangibility and Firm Exports

Dep. Var:	1	2	3	4	5	6	7
LEXP _f (linf, lsup)							
L _f	2.940***	2.890***	2.488***	3.280***	3.232***	2.935***	2.876***
L _f xTangBra _s	-3.388***	-3.259***	-2.861***	-1.406***	-1.293**	-1.132**	-0.989*
Exp09 _f			2.257***			2.110***	2.115***
Parent _f				-2.952***	-2.944***	-2.893***	-2.884***
Constant	12.047***	12.020***	10.206***	14.004***	13.993***	12.253***	12.233***
Controls:				Sector F.E.			
Region FE	No	Yes	Yes	No	Yes	No	Yes
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

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