# Newtoning financial development with heterogeneous firms

Rafael CEZAR [1]

Université Paris Dauphine, Place du Maréchal de Lattre de Tassigny, 75775 Paris Cedex 16, France. IRD UMR 225 DIAL, Paris, France.

E-mail : rafael.cezar@dauphine.fr or rafael.cezar@aol.com

**Abstract:** This article theoretically and empirically tests the link between financial constraints and the extensive (proportion of exporters) and intensive (volume of exports) margins of international trade. The article's main contribution is its macroeconomic analysis of this relationship, which is further reaching than the sector-based focus found in the current literature. It also presents new information on firm behavior under financial constraints. The paper develops a trade model with heterogeneous firms and shows that countries with a high level of financial development have a lower productivity cut-off above which firms export and a higher proportion of exporting firms. Nevertheless, financial development is not correlated with firms' export volumes once they become exporters. An empirical analysis is developed on the basis of an international trade database on 135 countries between 1994 and 2007. The empirical analysis estimates a two-step gravity equation using panel data and confirms the first theoretical proposition that finance has a positive impact on the extensive margin. However, the intensive margin results are striking. They find a negative relationship between financial development and trade flows, confirmed by all the sensitivity tests. Despite the positive effect of financial development found by the literature in some economic sectors, the macroeconomic impact on overall exports was negative during the analyzed period.

*Keywords:* *heterogeneous firms, trade, financial development.*
*Classification JEL:* *F12, G20, 016.*

---

# Introduction

This paper aims to theoretically and empirically demonstrate the potential relationship between firms' financial constraints and the extensive and intensive margins of international trade. The first margin is the proportion of exporting firms and the second is the total volume exported by countries. In other words, the paper studies the link between financial development and international trade. Its main contribution is a macroeconomic analysis of the effect of financial development on trade, which paints a broader picture than the sector-based focus found in the specialized literature. The article also provides new insight into exporting firms' behavior under financial constraints. Lastly, it uses a new specification of the gravity model, as proposed by Helpman, Melitz and Rubinstein (2008), based on panel data.

Since the 1990s, there have been many studies of the effects of financial development on a number of macroeconomic variables. The focus initially was on the link between finance and economic growth, with King and Levine (1993) rekindling the debate by showing that financial development is closely connected with real GDP growth, rising investment rates and better physical capital performance. A number of articles have followed up on this analysis. Among them, Rajan and Zingales (1998) test and confirm the proposition that financial development is more beneficial to industries dependent on external finance and that these industries therefore post higher growth rates in countries where the financial industry is more developed.

Several authors also confirm this relationship. According to most sources, there are many channels for the link between finance and growth. First, there is the effect of financial intermediation on the use of savings, on its allocation to the most efficient investment project, and then on the production of information about these projects. Financial systems influence growth in terms of exercising corporate governance and monitoring investment projects. They facilitate trade in goods and financial transactions among economic agents. Lastly, financial intermediation influences growth by sharing, diversifying and managing risks (Levine, 2005).

Literature on the financial effect on international trade appeared much later, with Beck (2002) among the pioneers. He empirically tests a Heckscher-Ohlin model, developed by Kletzer and Bardhan (1987), which discusses the role of credit market imperfections in international specialization. The model predicts that financially developed countries

specialize in manufacturing sectors rather than in agricultural sectors. The studies that followed were influenced by Rajan and Zingales and test the proposition that financially developed countries have a comparative advantage in industries intensive in external finance (see Beck 2003, Svaleryd and Vlachos 2005; Hur *et al.,* 2006). A new wave of literature appeared with the work of Chaney (2005) and Manova (2008) as firms' heterogeneity entered the debate.

The first author constructs a model of heterogeneous firms based on Melitz (2003). Firms are subject to financial constraints to pay export costs. The only firms that export are those whose profit, added to a liquidity shock, is higher than their exporting costs. Chaney demonstrates that there is a non-empty set of firms that are productive enough to export, but that do not export because of credit constraints. The second paper develops a similar model, but this time based on Helpman, Melitz and Rubinstein (2008). Manova shows that financial development is positively correlated with the extensive and intensive margins of trade and that this relationship is stronger in financially dependant industries. The empirical tests confirm her assumptions.

This paper continues the discussion and analyzes the macroeconomic effects of financial development on trade margins. I focus on identifying the effects of financial development on total trade to gain a broader picture than the sector-based effects sought by the literature. A theoretical model is constructed and then tested empirically.

Firms are heterogeneous by their productivity level and face fixed costs to export. Only firms that are productive enough to afford these costs can access foreign markets. I assume that firms finance all fixed costs via financial systems[2]. Credit markets are imperfect and this complicates the firms' access to external finance. Differentiating countries by their financial constraint level, the model finds that a higher proportion of firms export in financially developed countries. However, the volume exported by firms does not suffer from variations in financial level once they have become exporters. Therefore, the model does not determine a clear relationship between financial development and the intensive margin of trade. Two propositions are established. One is that financial systems have a positive effect on the

---

[2] In this simplification, industries are not differentiated by their financial needs.

extensive margin and the second tells that the relationship between financial development and the intensive margin is unclear.

An empirical analysis follows the model. These theoretical propositions are tested by the use of a sample of annual trade data covering 135 countries between 1994 and 2007. The financial constraint is measured by the ratio of total credit to the private sector and GDP.

To test the first theoretical proposition, I analyze the ratio of the productivity of the most productive firms to the productivity cut-off above which firms export (see equation 12). If it is higher than 1, at least one firm is productive enough to export, but if it is less than 1, no firm exports. Despite the lack of data on productivity levels and on their distribution, the existence or non-existence of trade is noticeable, and so the role of financial development on firm selection can be tested using a probit model. The results confirm the hypothesis and show that financial development lowers the productivity cut-off and raises the proportion of exporting firms.

The use of macroeconomic data for this estimate is possible because the characteristics of firms' exporting decisions can be identified from the analysis of the marginal variation of the data. Therefore, the gravity model framework is used for the estimates.

Subsequently, I test the effects of finance on the intensive margin by estimating a two-step gravity model. This procedure is envisaged to control for the endogenous proportion of exporting firms (extensive margin). The first step is the estimate of the extensive margin and the second is the estimate of trade flows using a traditional gravity equation controlling for the endogenous proportion of exporting firms (see equation 18)[3].

The main empirical results are striking. The coefficient of the financial variable is negative and significant for both tested specifications. This indicates that, over the fourteen years, the increase in financial development caused the reduction in total exports, all sectors together.

To evaluate the robustness of these results, I conduct a wide range of sensitivity tests. I test the independence of the relationship and control for a possible omitted variable bias. To reduce the possibility of simultaneous adjustments and ensure that a reverse causality bias

---

[3] To construct the controlling function, I assume that firms' productivity follows a Pareto distribution.

does not distort the results, I use a moving average for the financial indicator. I check the influence of outliers and also test the linearity of the financial variable. Lastly, I use other indicators to measure financial development. Subsequently, to test the robustness of the control function to the extensive margin, I relax the distribution assumption about firms' productivity and estimate a polynomial model. All these tests turn up merely marginal variations in the financial coefficient, which remains negative and significant.

The specialized literature points to a positive relationship between financial development and exports in industries dependent on external finance. The results in this paper are therefore complementary to this finding. It shows that the overall effect is negative and financial development reduces total exports. This find can be explained by the decrease in exports in some sectors that offsets the export growth driven by financial development in financially vulnerable industries. The *finance – intensive margin* relationship takes two distinct paths: financial development induces a reduction in total trade, as shown by this article, and, on the other hand, provokes a comparative advantage in financially vulnerable sectors, as shown by the literature.

There is a strong link between financial development and the extensive margin. However, the effects of finance on the intensive margin are ambiguous and depend mainly on each industry.

# 1) Theoretical model

This model seeks to clarify the relationship between financial development and countries' total trade. I introduce financial constraints into the Helpman, Melitz and Rubinstein model (2008), as in Manova (2008), but without differentiating between economic industries. Firms face fixed costs to export and finance all of them externally. Credit markets are imperfect and complicate the financing of these costs. The model differentiates countries by their levels of financial constraints to show that financial development raises the proportion of exporting firms. However firms' export volumes are independent of the financial constraint level once the trade relationship is established. The main findings are that financial development is positively correlated with the increase in the extensive margin, but its effect on the intensive

margin is uncertain. The link between finance and trade channels through the extensive margin.

## Set-up of the model

I consider a simple analytical framework with $i$ countries and one single industry, composed of $N_i$ heterogeneous firms in each country. Each firm produces a single variety of good, so they are monopolistic in their variety. Consumers like variety and they consume all goods on offer. They share the same preferences, represented by a constant elasticity of substitution (CES). The utility function of country $i$ is the sum of all individual CES functions:

$$U_i = \left( \int_{\omega \in \Omega_i} q_i(\omega)^\alpha \, d\omega \right)^{\frac{1}{\alpha}}$$

Where parameter $\alpha$ defines the constant elasticity of substitution across products, which equals $\varepsilon = 1/(1-\alpha)$, $0 < \alpha < 1$ and so $\varepsilon > 1$. Country $i$'s consumption of variety $\omega$ is denoted $q_i(\omega)$ and $\Omega_i$ is the set of all available varieties in this country. Each variety in the set is offered at price $p_i(\omega)$. The ideal price index is:

$$P_i = \left( \int_{\omega \in \Omega_i} p_i(\omega)^{1-\varepsilon} \, d\omega \right)^{\frac{1}{1-\varepsilon}} \qquad (1)$$

If $Y_i$ is the total income of country $i$, demand for the variety $\omega$ equals:

$$q_i(\omega) = \left( \frac{p_i(\omega)^{-\varepsilon}}{P^{1-\varepsilon}} \right) Y_i \quad (2)$$

## Production and trade costs

In line with Melitz (2003), firms face sunk costs to enter the domestic market. Only after entry that they learn their productivity level, which determines their profit level. To produce, firms use a combination of inputs and the cost of this combination to produce a unit of good is $c_i$, which is the output of a cost minimization program and is specific to each country.

Firms are heterogeneous by their productivity level, noted $\varphi$. Productivity follows a

cumulative distribution function $\mu(\varphi)$ with supports $[\varphi_B , \varphi_H]$ and $\varphi_H > \varphi_B > 0$, where $\varphi_H$ is the productivity of the most productive firm and $\varphi_B$ is the productivity of the less productive.

Firms have a cost function with constant returns. The unit cost of production in country $i$ is $c_i/\varphi$ where $1/\varphi$ measures the inputs used to produce a unit of good. Note that $c_i$ is specific to each country and it reflects differences between input prices across countries. In the other hand, $\varphi$ is specific to each firm and captures heterogeneity between them. I assume that $\mu(\varphi)$ is the same across countries and, therefore, differences in productivity levels across countries are captured by $c_i$.

Firms do not face fixed costs to produce for the domestic market. After paying the sunk cost, all firms can produce and sell on the domestic market. This simplification enables a focus on the firms' export decisions.

If firms export, they face two different costs: a fixed cost and a variable cost. The first one is specific to each country-pair and is the same for all firms. I denote $c_i f_{ij}$ as the fixed cost to export from country $i$ to country $j$, expressed in units of the factors bundle and normalized by the input cost. $f_{ij} > 0$ for all $i \neq j$ and $f_{ij} = 0$ if $i = j$. The variable costs take the form of an iceberg trade cost and $\tau_{ij} > 1$ unit of goods are shipped by country $i$ for 1 unit delivered to the destination. The total cost to export q units from $i$ to $j$ is:

$$c(q_{ij}) = q_{ij}\left(\frac{\tau_{ij}c_i}{\varphi}\right) + c_i f_{ij}$$

**Financial constraints and trade**

Firms face many costs to export, which should normally be payed before the start of the trade relationship, i.e. before profits are made. Unconstrained models assume that firms face no financial constraints to finance these costs. However, if financial systems are imperfect, another equilibrium should be calculated.

Fixed costs in international trade are highly diverse. They consist, for example, of investments to adapt production to a new market and new customers. Firms also need to seek new partners on foreign markets, pay translation costs, and comply with local legislation and local standards. Long lead-times between shipping and delivery are also a heavy burden. Additional difficulties are added to the magnitude of these costs because foreign activities are

normally riskier than domestic ones. Firms also have to contend with exchange rate, protectionist and political risks.

Subsequently firms' fixed export costs are large and risky, and firms need the financial system to finance these costs. If the financial system is fully efficient, equilibrium is the same as in the unconstrained model. But if the financial system is imperfect, firms have to contend with financial constraints to access external finance and export.

To model the effects of financial constraint on trade, I assume that the level of financial constraints varies between countries and that the characteristics of each system determine the firms' access to external finance and risk management. Firms use the financial systems to finance their entire fixed export costs[4] and I also assume that firms self-finance their variable costs without any difficulty (the results remain the same if this assumption is relaxed).

The export procedure is as follows: First firms seek the financial system to finance their fixed export cost. They already know their prices and the demand for each variety and therefore they are familiar with the export earnings and costs. Firms with enough net earnings (earnings minus variable costs) to pay for the loan borrowed in the first period, plus the cost of using the financial system, get the credit and export. In the last period, exporters refund the loan. Firms with lower forecast net earnings than the loan do not export.

Financial constraints are heterogeneous between countries. Each country has a different level of financial development, which is exogenous and denoted $\Theta_i$. To simplify, I assume $0 \leq \Theta_i \leq 1$, where $\Theta_i$ equals 1 when firms have no constraints on their access to credit and it equals zero otherwise. This index shows the level of financial development and so how firms access external finance.

To export to country $j$, firms in country $i$ are subject to the following constraint:

$$f(\theta_i)c_i f_{ij} \leq q_{ij}(\varphi)p_{ij}(\varphi) - q_{ij}(\varphi)\tau_{ij}\frac{c_i}{\varphi} \qquad \text{where} \qquad \frac{\partial f(\theta)}{\partial \theta} < 0$$

where $f(\Theta_i)$ is the cost of using external finance in country $i$. I assume that $f(\Theta=1) = 1$ and that $f(\Theta)$ is a strictly monotonic and continuous function, decreasing with $\Theta$. That means that

---

[4] They do not use profits from previous periods to finance current activities.

an increase in the level of financial development reduces the cost of external finance. $f(\Theta_i)c_i f_{ij}$ is the amount due at the end of the period, which must be at least equal to the firm's net earnings, otherwise firms cannot export.

**Equilibrium with financial constraints**

Equilibrium is characterized by a productivity cut-off above which firms export. Firms export if the activity is profitable, i.e. if their profit from exporting is at least equal to zero. Each producer is monopolistic in their variety and hence the equilibrium price is a mark-up of the variable cost. An exporter with productivity level $\varphi$ knows the demand from country $i$ and sells its variety to this country at price:

$$q_{ij}(\varphi) = \left( \frac{\tau_{ij} c_i}{\alpha \varphi} \right)^{-\varepsilon} \frac{Y_j}{P_j^{1-\varepsilon}} \qquad \text{and} \qquad p_{ij}(\varphi) = \left( \frac{\varepsilon}{\varepsilon - 1} \right) \frac{\tau_{ij} c_i}{\varphi} = \frac{\tau_{ij} c_i}{\alpha \varphi}$$

The earnings from sales to this country equal:

$$r_{ij}(\varphi) = \left( \frac{\tau_{ij} c_i}{\alpha \varphi P_j} \right)^{1-\varepsilon} Y_j = \left( \frac{p_{ij}(\varphi)}{P_j} \right)^{1-\varepsilon} Y_j \qquad (3)$$

And the profit function of this exporter is:

$$\Pi_{ij}(\varphi) = (1-\alpha) \left( \frac{p_{ij}(\varphi)}{P_j} \right)^{1-\varepsilon} Y_j - f(\theta_i) c_i f_{ij} \qquad (4)$$

The productivity cut-off above which firms export in the constraint model is noted $\varphi^*$. Only firms with productivity level above $\varphi^*$ can export. The cut-off is defined by the zero profit condition below:

$$\Pi(\varphi^*) = 0 \qquad (5)$$

This cut-off is country-pair specific and only firms with productivity higher than $\varphi_{ij}^*$ can export from country $i$ to country $j$.

Unfortunately, the productivity level is not easily observable. But as the firm's earnings are increasing with productivity, I use the earnings function as a proxy for firms' productivity level. The earnings cut-off above which firms export from country $i$ to $j$ is:

9

$$r_{ij}(\varphi_{ij}^{*}) = \left( \frac{p_{ij}(\varphi_{ij}^{*})}{P_j} \right)^{1-\varepsilon} Y_j = \frac{f(\theta_i)c_i f_{ij}}{1-\alpha} = \varepsilon \left( f(\theta_i)c_i f_{ij} \right) \qquad (6)$$

Only firms with earnings greater than $r_{ij}(\varphi^*)$ export. This threshold is increasing with $f(\Theta)$, and when the financial system develops, $f(\Theta)$ decreases, as does the productivity cut-off. This enables firms with a lower productivity index to access international markets. Hence a higher proportion of firms are able to export in financially developed countries.

**Financial constraints and the trade margins**

The extensive margin is the proportion of exporting firms. Given that firms' export decisions are based on the analysis of their profit function, the extensive margin is represented theoretically by the productivity cut-off. When this threshold decreases, the proportion of exporting firms increases.

The relationship between finance and the extensive margin channels through the productivity cut-off. When the financial system develops, $f(\Theta)$ decreases and the productivity cut-off is reduced. Firm selection broadens and less productive firms become exporters. This mechanism shows that financial development has a positive effect on the proportion of exporting firms. To demonstrate this effect, I calculate the elasticity of the productivity cut-off to the level of financial development:

$$\frac{\partial \varphi^*}{\partial \theta} \approx \frac{\partial r(\varphi^*)}{\partial \theta} < 0 \quad \text{because} \quad \frac{\partial f(\theta)}{\partial \theta} < 0 \qquad (7)$$

This elasticity is negative, confirming the inverse relationship between $\varphi^*$ and $\Theta$. This result shows that financial development is a determinant of the extensive margin of trade. The first theoretical proposition is defined as follows:

<u>Proposition 1</u>: *Financial development is positively correlated with the extensive margin of trade such that when the financial system develops, a greater proportion of firms export.*

To analyze the relationship between finance and the intensive margin, I define $V_{ij}$ as the endogenous proportion of exporting firms. It is a function of the productivity distribution and the productivity cut-off, as below:

$$V_{ij} = \begin{cases} \int_{\varphi^*}^{\varphi_H} \varphi^{1-\varepsilon} d\mu(\varphi) & if & \varphi^* \leq \varphi_H \\ 0 & if & \varphi^* > \varphi_H \end{cases} \quad (8)$$

If $\varphi^* > \varphi_H$, then $V_{ij} = 0$ because the productivity cut-off is higher than the productivity of the most productive firm and no firm is productive enough to export[5]. If $\varphi^* < \varphi_H$, then $V_{ij} > 0$ and at least one firm is productive enough to export. And when $\varphi^*$ decreases, the number of exporting firms increases. This variable is country-pair specific and I assume that $V_{ij} \neq V_{ji}$[6].

The value of total exports from $i$ to $j$ is the sum of firms' individual exports. It is a function of the firms' export earnings, the size of the country (measured by the number of firms) and the proportion of exporting firms. $X_{ij}$ is defined as follows:

$$X_{ij} = \left( \frac{\tau_{ij} c_i}{\alpha P_j} \right)^{1-\varepsilon} Y_j N_i V_{ij} \quad (9)$$

The scale of $X_{ij}$ depends essentially on the volume of individual exports and on the extensive margin, after controlling for country size. The first equals the export earnings of each firm and is not affected by the level of financial development. Effectively, as the productivity distribution function is the same for all countries and because prices are a constant mark-up of variable costs, individual export earnings are not affected by $\Theta$ (see equation 3). Nevertheless, as the proportion of exporting firms is a positive function of $\Theta$, the link between finance and intensive margin channels through the extensive margin. However, once controlled for the endogenous proportion of exporting firms, the theoretical model does not suggest a clear relationship between financial development and trade flows. The second proposition is made:

Proposition 2: *The theoretical effect of financial development on the intensive margin is unclear. This assumption is true if proposition 1 is borne out.*

---

[5] Therefore $V_{ij}$ takes into account the zero-trade observations.

[6] This hypothesis allows for asymmetric trade flows between a country pair.

## 2) Empirical model

A gravity equation is developed from the previous model to empirically test the theoretical assumptions. The gravity model is one of the most successful models in international economics and a number of specifications have already been tested. I follow Helpman *et al.* (2008) and estimate a two-step gravity equation with control for the extensive margin.

The log-linearization of equation 9 enables that total exports from country $i$ to $j$ can be written as follows:

$$\ln X_{ij} = (1-\varepsilon)\ln c_i + (1-\varepsilon)\ln \tau_{ij} + (\varepsilon-1)\ln\alpha + (\varepsilon-1)\ln P_j + \ln Y_j + \ln N_i + \ln V_{ij} \quad (10)$$

I assume that $\tau_{ij}$ is a stochastic cost consisting of a country-pair's specific costs and an i.i.d trade friction. I also assume that $\tau_{ij}^{1-\varepsilon} = D_{ij}^a e^{u_{ij}}$, where $D_{ij}$ denotes the distance between the two countries and $u_{ij} \sim N(0,\sigma_u^2)$. Representing the logarithms with lower case letters, I rewrite equation 10:

$$x_{ij} = \chi_0 + \chi_i + \chi_j + aD_{ij} + v_{ij} - u_{ij} \quad (11)$$

where $\chi_i = (1-\varepsilon)\ln c_i + \ln N_i$ and $\chi_j = (\varepsilon-1)\ln P_j + \ln Y_j$ represent the trade barriers specific to the exporting and importing countries respectively. $\chi_i$ is the same for any country to which $i$ exports and $\chi_j$ is identical for all countries that export to $j$.

Equation 11 is very similar to a traditional gravity equation. However $v_{ij}$ differentiates (11) from the traditional models, such as that presented by Anderson and Wincoop (2003).

### The role of financial systems in firms' selection

According to the theoretical assumptions, financial development lowers the productivity cut-off above which firms export. This enables less productive firms to access foreign markets. The financial system plays a role in firms' selection into export.

To study this relationship, I start by defining the latent variable $Z_{ij}$ as the ratio of the productivity of the most productive firm – $\varphi_H$ – to the productivity cut-off specific to $ij$ – $\varphi_{ij}^*$. If $\varphi_H < \varphi_{ij}^*$, the productivity cut-off is higher than the productivity of the most productive firm and no firms export from country $i$ to $j$. But if $\varphi_H > \varphi_{ij}^*$, there is a set of firms whose

productivity is above the productivity cut-off, and these firms export. In the first case, $Z_{ij}$ is less than 1, and in the second case, $Z_{ij}$ is necessarily greater than 1. This latent variable therefore reveals whether the two countries trade, and it is defined as:

$$Z_{ij} = \left(\frac{\varphi_H}{\varphi_{ij}^*}\right)^{\varepsilon-1} = \frac{\left(P_j \dfrac{\alpha}{\tau_{ij} c_i}\right)^{\varepsilon-1} Y_j}{\varepsilon\left(f(\theta_i) f_{ij}\right)} \varphi_H^{\varepsilon-1} \quad (12)$$

where $f_{ij}$ denotes country-pair trade frictions and represents the specific trade costs to export from $i$ to $j$. I assume $f_{ij} = \exp(\phi_i + \phi_j + \phi_{ij} + \upsilon_{ij})$ where $\upsilon_{ij} \sim N(0, \sigma_\upsilon^2)$. $\phi_i$ is a measurement of country $i$ export costs while $\phi_j$ denotes a common trade barrier to any country that exports to $j$, and $\phi_{ij}$ is a country-pair specific cost. Using these specifications and log linearizing (12), $Z_{ij}$ can be expressed as:

$$z_{ij} = \gamma_0 + \gamma_i + \gamma_j + \gamma_{ij} + f(\theta_i) + \eta_{ij} \quad (13)$$

where $z_{ij}$ is the log of $Z_{ij}$. $\gamma_i = \phi_i-(1-\varepsilon)\ln c_i$ and $\gamma_j = \phi_j-(\varepsilon-1)\ln P_j+\ln Y_j$ represent the characteristics of exporting and importing countries respectively. $\gamma_{ij}$ represents the fixed effect specific to the country pair and $\eta_{ij} \equiv u_{ij} + \upsilon_{ij} \sim N(0, \sigma_u^2 + \sigma_\upsilon^2)$ is an i.i.d. error term.

As a latent variable, $Z_{ij}$ is not observable. Nevertheless, I can observe whether countries trade between them, and it can be used as a proxy for $Z_{ij}$. I define the dummy variable $T_{ij}$ as an indicator of the existence of trade flows. Therefore, $T_{ij} = 1$ if $Z_{ij} > 0$ and $T_{ij} = 0$ if $Z_{ij} < 0$. As it is an observable variable, I can estimate $Z_{ij}$ from $T_{ij}$. And as the disturbance $\eta_{ij}$ follows a normal law with variance $\sigma_\eta^2$, the standardization to the unit of this variance enables the estimation of $Z_{ij}$ by a probit model using $T_{ij}$ as the dependent variable. As $T_{ij}$ equals 1 when country $i$ exports to $j$, then the conditional probability that $i$ exports to $j$ – $\rho_{ij}$ – is given by the following probit equation:

$$
\begin{aligned}
\rho_{ij} \quad &= \Pr\left(T_{ij} = 1 \middle| \text{observed variables}\right) \\
&= \Pr\left(z_{ij} > 0 \middle| \text{observed variables}\right) \\
&= \Pr\left(\gamma_0 + \gamma_i + \gamma_j + \gamma_{ij} + f(\theta_i) \geq \eta_{ij}\right)
\end{aligned}
$$

Defining $Z_{ij}^*$ as:

$$Z_{ij}^* = \left(\gamma_0 \gamma_i \gamma_j \gamma_{ij} f(\theta_i)\right)^{\frac{1}{\sigma_\eta}}$$

I can then estimate the probability $\rho_{ij}$ using the following probit equation:

$$\rho_{ij} = \Phi(\beta z_{ij}^*) \quad (14)$$

where $z_{ij}^*$ is the logarithm of $Z_{ij}^*$ and $\Phi(\bullet)$ is the cumulative distribution function of a standard normal law.

This equation enables $Z_{ij}$ to be estimated by a probit model using observable variables from the exporting and importing countries. I can then analyze the effect of these variables on the existence of trade between two countries, more precisely the financial effect on the extensive margin. A positive coefficient indicates, for example, that a positive variation in the variable induces an increase in $Z_{ij}$, by reducing the productivity cut-off or by increasing firm productivity[7]. Therefore the effect of financial development on firms' selection can be tested empirically.

It is important to note that the selection equation is derived from a firm-level decision, and shows how changes in country characteristics affect firms' incentives to export. However, it does not contain direct information on the endogenous proportion of exporting firms, but on its marginal variation. Moreover, equation 14 can be used to derive consistent estimates of $V_{ij}$, as can be seen in the next section.

## Finance and the intensive margin

I draw on Chaney (2008) and assume that $\varphi$ follows a truncated Pareto distribution[8] and that its distribution function respects $\mu(\varphi) = (\varphi^k - \varphi_B^k) / (\varphi_H^k - \varphi_B^k)$, where $k > (\varepsilon - 1)$. Equation 8 can thus be rewritten as:

$$V_{ij} = \frac{k}{(k - \varepsilon + 1)(\varphi_H^k - \varphi_B^k)} \varphi_{ij}^{*(k-\varepsilon+1)} W_{ij}$$

---

[7] Expressed by a higher $\varphi_H$.

[8] Chaney (2008) argues that this distribution law is a good approximation of the true firm productivity distribution. Helpman *et al.* (2008) relax this distributional assumption and conclude that *"Pareto distribution does not appear to restrict the basic specification of the model"*.

And:

$$W_{ij} = Max\left\{\left(\frac{\varphi_H}{\varphi_{ij}^*}\right)^{k-\varepsilon+1} - 1,\ 0\right\}$$

I next rewrite $V_{ij}$ as a monotonic function of $W_{ij}$[9]. With these assumptions, this variable captures the extensive margin or the endogenous number of exporting firms, and also the existence of trade between the two countries. As the distribution function of $\varphi$ supports $[\varphi_B, \varphi_H]$ and $\varphi_H > \varphi_B > 0$, if $\varphi_H < \varphi_{ij}^*$, no firm is productive enough to export and $W_{ij} = 0$, as $X_{ij}$. And if $\varphi_H > \varphi_{ij}^*$, $W_{ij}$ (as a monotonic function of $V_{ij}$) captures the proportion of exporting firms. As $Z_{ij}$ is the ratio of the productivity of the most productive firm to the productivity cut-off, I can rewrite $W_{ij} = Max\left\{Z_{ij}^{\frac{k-\varepsilon+1}{\varepsilon-1}} - 1,\quad 0\right\}$. If $\hat{\rho}_{ij}$ is the estimated probability that $i$ exports to $j$, $\hat{z}_{ij}^* = \Phi^{-1}\left(\hat{\rho}_{ij}\right)$ and the endogenous proportion of exporting firms can be estimated from observed variables using the following equation:

$$\hat{W}_{ij}^* = Max\left\{\left(\hat{Z}_{ij}^*\right)^{\ell} - 1,\quad 0\right\} = T_{ij}\left\{\left(\hat{Z}_{ij}^*\right)^{\ell} - 1,\quad 0\right\} \qquad (15)$$

where $\ell = \dfrac{k-\varepsilon+1}{\varepsilon-1}\sigma_\eta$.

Using these specifications, I estimate equation 11 in two steps. The first is the estimate of $W_{ij}$ above, using information from the probit (14). In the second step, I estimate $x_{ij}$ controlling for the endogenous proportion of exporting firms, with $w_{ij}$ calculated in the first step. Equation 11 can be rewritten as follows:

$$x_{ij} = \chi_0 + \chi_i + \chi_j + aD_{ij} + b\ln\varphi_{ij}^* + w_{ij} - u_{ij}$$

---

[9] By substituting $v_{ij}$ with $w_{ij}$, the constant term of $v_{ij}$, precisely $\left(\dfrac{k}{(k-\varepsilon+1)\left(\varphi_H^k - \varphi_B^k\right)}\right)$, is added in the constant.

where b = k – ε + 1. As the productivity cut-off is not observed, I use equation 6 to substitute it in the equation by $\beta_0 + (\varepsilon-1)\ln P_j + \ln Y_j - \varepsilon\ln c_i - \ln f(\Theta) + a\ln D_{ij} - u_{ij} + \phi_i + \phi_j + \phi_{ij} - \upsilon_{ij}$, where $\upsilon_{ij} \sim N(0, \sigma_\upsilon^2)$. I estimate the value of total exports from $i$ to $j$ as:

$$x_{ij} = \Psi_0 + \Psi_i + \Psi_j + \Psi_{ij} + f(\theta_i) + w_{ij} + e_{ij} \quad (16)$$

where $\psi_i = \chi_i + \varepsilon\ln c_i + \phi_i$ and $\psi_j = \chi_j + (\varepsilon-1)\ln P_j + \phi_j$ represent trade barriers specific to countries $i$ and $j$ respectively. The term $\psi_{ij} = aD_{ij} + \phi_{ij}$ denotes bilateral trade costs specific to the country pair $i\,j$. $e_{ij} \sim N(0, \sigma_u^2 + \sigma_\upsilon^2)$ is an i.i.d. measurement error.

## Estimation methodology

Under the financial constraint hypothesis, the development of financial systems plays a positive role in firms' selection into trade. It reduces the financial constraint, enabling a larger proportion of firms to export. To test this assumption, I estimate equation 14. As shown above, I use the traditional gravity equation's framework to estimate the probit equation below:

$$\rho_{ij,t} = \Phi \begin{pmatrix} \beta_{1t}\ln\theta_i + \beta_{2t}\ln Dist + \beta_{3t}\ln Y_{i,j} + \beta_{4t}\ln Pop_{i,j} + \beta_{5t}FTA_{ij,t} \\ \beta_{6t}WTO_{ij,t} + \beta_{7t}Currency_{ij,t} + \beta_{8t}Contig_{ij} + \beta_{9t}Lang_{ij} \\ \beta_{10t}Colony_{ij} + \beta_{11t}SameCtry_{ij}\beta_{12t}Landlocked_{ij} \\ \beta_{13t}Island_{ij} + \beta_{0t} + \beta_t \end{pmatrix} \quad (17)$$

where $i$ et $j$ denote the exporting and importing countries respectively and $t$ the year. *Dist* is the distance between two countries. *Y* is real GDP, *Pop* is the population. These are country-specific variables. *FTA* indicates the existence of a free trade agreement between $i$ and $j$. *WTO* equals 1 if the two countries in the pair are members of the World Trade Organization. *Currency* indicates whether $i$ and $j$ share a common currency. *Contig, Lang, Colony and SameCtry* are dummy variables and, when equal to 1, indicate respectively a common border, a common language, a colonial link in the past and whether the two countries have been the same country in the past. Landlocked and Island indicate the number of landlocked countries

and islands in the country pair[10].

This empirical model uses an analytical gravity framework, with aggregate statistics, to analyze the microeconomic impact of heterogeneous firms' exporting decisions. This property results from the fact that the characteristics of marginal exporters (increase or decrease of the productivity cut-off) can be identified from marginal variations in the features of exporting and importing countries and in the observable trade costs. This is one of this approach's major advantages, since it enables the use of a macroeconomic framework to extract firm-level information, which would normally require a micro database.

I then analyze the impact of financial development on the intensive margin of international trade, by estimating equation 16. This equation is very similar to a traditional gravity equation, but with a control function for the extensive margin of trade. I estimate this equation in a two-step procedure. In the first step, I estimate $\hat{\rho}_{ij,t}$ and calculate $\hat{z}_{ij}^{*} = \Phi^{-1}\left(\hat{\rho}_{ij,t}\right)$ and then $w_{ij}$ can be estimated by equation 15. The second step is the gravity equation below:

$$
\begin{aligned}
x_{ij,t} = \ & Y_1 \ln \theta_{i,t} + Y_2 \ln Dist_{ij} + Y_3 \ln Y_{i,j_t} + Y_4 \ln Pop_{i,j_t} + Y_5 FTA_{ij,t} \\
& Y_6 WTO_{ij,t} + Y_7 Currency_{ij,t} + Y_8 Contig_{ij} + Y_9 Lang_{ij} + \\
& Y_{10} Colony_{ij} + Y_{11} SameCtry + Y_{12} \ln Area_{i,j} + Y_{13}\, \hat{w}_{ij,t}^{*} \quad\quad (18) \\
& Y_{14} \lambda\left( \hat{z}_{ij,t}^{*} \right) + Y_i + Y_j + Y_t + Y_0 + e_{ij,t}
\end{aligned}
$$

where $Y_i$, $Y_j$ and $Y_t$ represent respectively the controls for exporter and importer fixed effect and the time fixed effect. $\lambda\left( \hat{z}_{ij,t}^{*} \right) = \phi\left( \hat{z}_{ij,t}^{*} \right) / \Phi\left( \hat{z}_{ij,t}^{*} \right)$ is the inverse of the Mills ratio and $Y_{14}$ = cov $(e_{ij,t}, \eta_{ij,t}) \sigma_{e_{ij,t}}^{2}$. $Y_{14} \lambda\left( \hat{z}_{ij,t}^{*} \right)$ is the normal procedure to control for selection bias since $E(e_{ij,t} \mid x_{ij,t} > 0) \neq 0$, since zero-trade observations constitute almost 30% of the sample (see

---

[10] See the next section for more details.

Heckman, 1979, and Wooldridge, 1995). The variable $w_{ij,t}$ is also constructed with information from 17 and thus suffers from a selection bias. Therefore I use

$$\overline{w}^*_{ij,t} = \ln\left\{ \exp\left[ \hat{\ell}\, \overset{\wedge *}{z}_{ij,t} + \phi\left( \overset{\wedge *}{z}_{ij,t} \right) / \Phi\left( \overset{\wedge *}{z}_{ij,t} \right) \right] - 1 \right\}$$ instead of $w_{ij,t}$[11], since $\overline{w}^*_{ij,t}$ is a consistent

estimator of $E(w_{ij,t} | ., T_{ij,t} = 1)$ (see Santos Silva and Tenreyro, 2009).

Estimating 18, using the Heckman correction, calls for some strong assumptions about the model's parameters. Mostly about the normality assumption of the unobserved trade costs. A less restrictive control is the semi-parametric model, which entails the selection of some excluded variables (see Das, Newey and Vella, 2003). These variables should be correlated with the fixed costs, but they should not be directly correlated with $e_{ij,t}$. The fixed-effect model does not require such a specification, since all time-invariant variables are already excluded. In all the other specifications, I exclude the exogenous variables *Landlocked* and *Island*.

# 3) Data

The empirical analysis uses an international database on trade between 135 countries. Data are annual and cover the period between 1994 and 2007. Trade data are taken from the International Monetary Fund's Direction of Trade Statistics. The data are in current and undeflated US millions of dollars. Each country pair has two distinct observations: exports from *i* to *j* and exports from *j* to *i*.

Data to measure Gross Domestic Product comes from two different sources: the IMF's *World Economic Outlook Database* and the World Bank's *World Development Indicators*. Data are in current US$ and are not deflated. The population variable was constructed using

---

[11] Where $\phi\left( \overset{\wedge *}{z}{ij},t \right) / \Phi\left( \overset{\wedge *}{z}{ij},t \right)$ is the inverse of the Mills ratio.

information from the World Bank's *Health, Nutrition and Population Statistics* rounded out with data from the *Pen World Table (*http://pwt.econ.upenn.edu/*).*

The distance variable is based on data weighted by the population's geographic distribution. This variable as well the dummy variables *Contig*, *Lang*, *Colony*, S*ameCtry* and *Landlocked,* were taken from the CEPII *Distance* database (http://www.cepii.fr/francgraph/bdd/distances.htm).

The *Free Trade Agreements* variable was constructed entirely from World Trade Organization information on regional trade treaties (data are available on the website: http://rtais.wto.org/UI/PublicSearchByCr.aspx). By regional treaties, I mean free trade agreements and customs unions. The *WTO* variable was also constructed from information available on the WTO website (http://www.wto.org/english/thewto_e/gattmem_e.htm and http://www.wto.org/english/thewto_e/whatis_e/tif_e/org6_e.htm). Currency comes from an update of the database provided by Glick & Rose (2002)[12].


## Financial development

Levine (2005) states that financial development reflects the balance between savers and borrowers and the maximization of their interest. To promote this equilibrium's efficiency, the system must properly fulfill the functions of savings mobilization, capital allocation, risk management, firm monitoring and information sharing. In this context, a good financial indicator would ideally be sensitive to the efficiency of intermediaries at fulfilling all these functions. However, such measures are unfortunately not available for a sufficient number of countries to be able to conduct an international comparative study. Therefore, I follow the literature and use the most traditional financial development indicator: *Private.*

The indicator is a measure of the amount of credit granted to the private sector. More specifically, it equals the ratio of private credit provided by deposit money banks and other financial institutions to GDP. It is an important indicator because it measures the relative

---

[12]  I also use their definition of monetary union: the exchange rate between two currencies is fixed or unchanged so that price conversion is not required to trade between the two countries.

amount of loans allocated to the private sector, so it provides a good measurement of the financial constraints faced by firms. The lowest value of this indicator is zero, which indicates an economy with no private credit. An increase in the indicator points to the development of the financial system.

Data on this variable are available for the 14 years and the 135 selected countries. Data are provided by the World Bank. I use two different sources: the database provided by Beck, Demirguc-Kunt and Levine (2000)[13,] and the *Global Development Finance* database.

# 4) Estimating trade margins

In this section, I use the empirical model presented above to test the two theoretical assumptions. More precisely, I empirically test the link between financial development and the extensive and intensive margins of trade.

I first test the theoretical assumption of the positive effect of finance on the extensive margin. This hypothesis states that when the financial constraint is relaxed, the productivity cut-off above which firms export is lowered and a greater proportion of firms are able to export. To test this assumption, I estimate equation 17 using a probit model with the traditional gravity framework as explanatory variables to control for country features and trade costs. Like Berthou (2010), I estimate equation 17 using a Random Effect Probit model and I control for time effects using time dummies. To test the robustness of the results under this specification, I also estimate equation 17 using a Probit Population Averaged model and a Fixed Effect Logit model, both with panel data. Results are presented in Table I[14].

The first column shows the coefficients for the Probit Random Effect model. The dependant variable is a dummy variable that indicates whether the country pair trade ($T_{ij}$ = 1) or not ($T_{ij}$

---

[13] I use the database updated in April 2010.

[14] These estimates use panel data to simplify the presentation of the results. However, despite this panel estimate, I draw on Wooldridge (1995) to construct the control function for the selection bias and the extensive margin in the estimation of the intensive margin. That means that I use a different coefficient for each of the 14 years to the construction of $Z_{ij}$.

= 0). All the traditional control variables have the expected sign, which demonstrates a good fit of the model. The *Distance* coefficient is negative and indicates that a positive variation in this variable reduces the probability of two countries trading and reduces $z_{ij}$. In other words, an increase in distance raises trade costs and increases the productivity cut-off above which firms export[15]. This, in turn, reduces the proportion of exporting firms. The GDP coefficients are positive, as expected. The analysis also turns up a positive correlation between a firm's selection into trade and membership of a free trade zone, World Trade Organization membership and sharing a common currency. All these variables reduce trade costs and therefore reduce $z_{ij}$ by reducing the productivity cut-off. And thus this mechanism plays a positive role in firm selection. The effect of a common border is the only exception: despite its effect on the reduction of trade costs, this variable has a negative coefficient. I attribute this result to the effect of border conflicts, which stem trade between neighbors.

As expected by the theoretical assumption, the financial indicator coefficient is positive and significant. It shows that a positive variation in *Private* raises $z_{ij}$ by reducing the productivity cut-off. This allows that less productive firms export, meaning that a higher proportion of firms can export. The results confirm the first theoretical proposition.

I then estimate 17 using a Probit Average Population model, also with panel data. The results are presented in the second column of the table. In general, all the coefficient values are lower than with the random effect model, but they have both the same sign and are significant. The financial indicator is positive and significant at 1%, confirming the previous result. The third column shows 17 estimated using a Logit Fixed Effect model[16]. The *Private* coefficient is also positive under this specification, confirming the positive role of financial development in firm selection into export[17]. When financial constraints are eased, a higher proportion of firms access foreign markets.

---

[15] Or reduces $\varphi_H$, but I assume $\mu(\varphi)$ to be exogenous.

[16] Despite the change in distribution hypothesis, the probit and logit estimators are very similar, which makes it possible to test the robustness of the results using a fixed effect model.

[17] Nevertheless, it is not interpreted in the same way as with the other two models, because this model estimates the within variance. As the dependent variable is a dummy, the fixed effect coefficient indicates the probability of switching from exporter to non-exporter and vice versa. Therefore, the sample is reduced by about a third since it includes only the country-pairs whose dependent variable has changed from 0 to 1 or otherwise.

Next, I estimate a gravity equation to test the second theoretical assumption. The model suggests that the link between finance and trade goes through firm's selection into export. However, once firms have become exporters, the value of their exports is not affected by the level of financial constraints. The theoretical model, therefore, puts forward an unclear relationship between financial development and the intensive margin of trade. I test this relationship by estimating equation 18 using a two-step gravity model with panel data. The first stage is the previous probit equation. I then use these results to calculate $\overline{w}^{*}_{ij,t}$ [18] and then I estimate the trade flows, controlling for the endogenous proportion of exporting firms using.

The log-linearization of (18) enables the estimate of the equation using an ordinary least squares (OLS) model. As about 30% of the sample comprises zero-trade observations, this specification suffers from a selection bias because the conditional expectation of the error term is not zero, which means that $E(e_{ij,t}|x_{ij,t}>0) \neq 0$. I control for this bias by introducing the inverse Mills ratio. I also estimate the relationship using a non-linear model to control for the robustness of the results. I follow Silva and Tenreyro (2009) and I use the Poisson Pseudo Maximum Likelihood model[19]. As the data are in panel, the two specifications use the fixed-effect model (Anderson and Wincoop, 2003) and I control for the time effect. The results are given in the first two columns of Table II. The first column presents the OLS coefficients and the second column the PPML model. The standard deviations are robust in the two specifications[20] and the dependent variable is total exports from country $i$ to $j$ in the non-

---

[18] As in the empirical model, I calculate $\overline{w}^{*}_{ij,t} = \ln\left\{ \exp\left[ \hat{\ell}\, \hat{z}^{*}_{ij,t} + \phi\left( \hat{z}^{*}_{ij,t} \right) / \Phi\left( \hat{z}^{*}_{ij,t} \right) \right] - 1 \right\}$ to control for firm

heterogeneity. I calculate this statistic from $\hat{z}^{*}_{ij} = \Phi^{-1}\left( \hat{\rho}_{ij} \right)$. However, the data characteristics complicate this calculation: the sample includes a relatively small number of country pairs whose characteristics are such that their probability of trade is indistinguishable from 1. Differences in $z^{*}_{ij}$ are so not observable in the sample as a function of $\rho_{ij,t}$. Therefore, I attribute the same $z^{*}_{ij}$ for these country pairs as $\rho_{ij,t} > 0,999999$, which represents about 4.03% of the sample.

[19] The dependent variable in this specification is not in log and therefore all the observations are estimated. In this case, there is no selection bias and the Heckman correction is not used.

[20] I use the *cluster* and *robust* option in the estimate. The bootstrap method does not change the significance of

linear specification and its log in the linear model.

The coefficients of the control variables have the expected sign and show a good fit of the model. The variables of D*istance*, *Common Border, Language, Colony and SameCtry* were not estimated in the linear model because they are all time invariant. Nevertheless, their coefficients have the expected sign in the non-linear model. *GDP* is positive and significant in the two specifications, indicating that increases in these variables raise export value. The *Free Trade Agreement* variable is positive and confirms the hypothesis that trade agreements raise trade value. *WTO* is also positive, as is C*urrency*, indicating that membership of the World Trade Organization and sharing the same currency both increase trade flows. These results confirm the recent gravity literature, even using this new gravity specification (see, for example, Baier & Bergstrand, 2007; Rose, 2004; and Glick & Rose, 2002).

The control function for extensive margin $w_{ij,t}$ has a positive coefficient, as expected (see Chaney, 2008), and shows that an increase in the proportion of exporting firms generates a positive variation in export volume. $w_{ij,t}$ is also significantly different from zero. This finding demonstrates the robustness of this control and the importance of the extensive margin to the estimate of a gravity model.

The financial indicator *Private* has a negative coefficient in both specifications tested. It measures financial development and the results find that a positive variation in the level of financial development during the analyzed period induced a negative variation in trade flows, after controlling for the endogenous proportion of exporting firms. In other words, the results find a negative elasticity between trade flows and financial development. The two coefficients are significant at 1%.

I then relax the parametric hypothesis about the pareto distribution of firm productivity in equation 8. Using equations 6 and 12, I assume that $v_{ij} \equiv \xi(z_{ij})$ is an increasing function of $z_{ij}$. The controlling function for the extensive margin in equation 18 is switched from $\overline{w}_{ij,t}^{*}$ to $\xi(z_{ij,t}^{*})$, which I approximate with a polynomial in $z_{ij,t}^{*}$. I re-estimate equation 18 for the linear and non-linear models using this new polynomial function to control for the

the coefficients.

endogenous proportion of exporting firms. The results are presented in the third and fourth columns of Table II[21].

The changes in the coefficients and in the standard deviation are marginal under this new specification and the new results are very similar to the parametric model. The financial indicator is negative and significant at 1%, as it was before. This new specification confirms the previous results and indicates a negative relationship between financial development and international trade flows, after controlling for the extensive margin.

Two recent papers are consistent with these main findings. Berman and Héricourt (2010) analyze a sample of 5,000 firms in nine developing countries. They observe a disconnection between financial development and the intensive margin of trade, despites a positive relationship between firms' access to credit and their export decision. Muûls (2008) presents similar findings using microdata from 9,000 Belgian firms between 1999 and 2005. He finds a positive effect on the extensive margin and his estimates suggest a vague and insignificant effect of financial development on the intensive margin. The authors conclude that once firms become exporters, credit constraints affect neither their export value nor their growth.

Unlike these results, the core body of literature[22] finds a positive relationship between finance and the intensive margin of trade. Yet this literature analyzes the relationship differentiating the economic sectors by their level of dependence on external finance. This paper studies the macroeconomic effects of financial development on total exports across all economic sectors. The findings indicate that, over the fourteen years studied, financial development caused a negative variation in overall exports, all industries combined, despite a positive impact on the extensive margin. The link between finance and trade channels through the extensive margin. The impact of financial development on the intensive margin is uncertain and was negative between 1994 and 2007.

---

[21] The first step is the same in the four specifications.

[22] See Beck (2003), Svaleryd & Vlachos (2005), Hur *et al.* (2006) and Manova (2008).

# 5) Sensitivity analyses

I perform a wide range of sensitivity analyses to assess the robustness of the empirical results. First, I consider a set of additional control variables to control for the independence of the relationship between financial development and the intensive margin of trade (see table III). More specifically, there is a vast body of literature showing that good policy and institutional environment promote better trade performance (see Levchenko, 2007). The correlation between these economic characteristics and financial development could therefore explain the previous results. I use two democratic development indicators, a political environment measurement, a political sustainability indicator and an indicator of the level of political authority and corruption. Data are available from *Polity IV* and the World Bank. None of the specifications tested changes either the sign or the significance of the financial coefficient[23].

The empirical results could also be influenced by a reverse causality bias (see Do & Levchenko, 2007). Income and credit in the economy may vary with exports, which would result in an endogenization of the financial indicator. To control for this bias, I use a 3-, 5- and 7-years moving average for the financial indicator (see table IV). This procedure reduces the possibility of simultaneous adjustments between trade and finance. The results confirm the findings in Table II. The coefficients are negative with all three indicators in the linear and non-linear models.

I then check the influence of outliers. First, I examine the residuals from the linear regression. I remove all observations with a residual greater than three standard deviations from zero and I re-estimate the linear model. Then I remove the five countries that export the most and the least, and I re-estimate equation 18. The financial variable's coefficient is negative and significantly different from zero in both specifications tested.

I also select four different measurements of financial development to test whether the results are robust to the choice of indicator (table V). The four variables selected are those the most

---

[23] The estimate's first step remains the same for all robustness tests.

often used by the literature: *Bank, Financial Depth, Capitalization* and *Liquidity*[24]. The first measures the ratio of bank deposits to total deposits. *Financial Depth* measures total financial intermediation as a percentage of GDP. The last two variables measure stock market development: C*apitalization* equals the ratio of market capitalization to GDP while *Liquidity* measures market liquidity. Despite the robustness of the results using *Private*, in general, these four indicators' coefficients are not significantly different from zero. The only exception is *Liquidity*, whose coefficients are negative and significant at 1% in both linear and non-linear models. However, the sign and significance of the other variables are inconstant and depend on the model estimated.

Lastly, I test the linearity of the financial effects on exports. I separate the 135 countries into five sub-groups by their stage of financial development and I create a dummy for each group. I then interact these variables with *Private* (results are in table VI). Both linear and non-linear model estimates using the dummies find negative coefficients for the five sub-groups. This suggests that the results are not influenced by a specific country category. However, the least developed group has a insignificant coefficient in both models, indicating that financial improvements at this development stage do not affect trade.

## Conclusions

This article explores the relationship between firms' financial constraints and the margins of international trade. It is part of a recent body of literature, to which it contributes in two main ways. First, the article examines the macroeconomic impact of the relationship, broadening the sector focus found elsewhere in the literature. Second, it provides new information about firms' exporting behavior under financial constraints.

The article constructs a theoretical model, which is tested by an empirical analysis, showing that the level of financial development is positively correlated with the proportion of

---

[24] Data are available from the World Bank.

exporting firms (the extensive margin). However, once the relationship is established, the volume of firms export is not affected by changes in financial constraints. Therefore, the theoretical model does not define a clear relationship between finance and trade flows (the intensive margin).

The empirical analysis draws on a panel database covering 135 countries between 1994 and 2007. I estimate a probit model to test the effect of finance on the extensive margin. The results confirm the theoretical proposition. I then estimate a two-step gravity equation to analyze the effects of finance on trade flows. The results are striking, turning up a negative relationship between financial development and the intensive margin.

The link between finance and trade channels through firm selection. When the financial constraints are relaxed, the productivity cut-off above which firms export is reduced and a greater proportion of firms can access foreign markets. In the other hand, the finance - intensive margin relationship follows two distinct paths. The literature differentiates the industries by their level of dependence on external finance and finds that financial development translates into a comparative advantage in financially vulnerable sectors. This article demonstrates, however, that the macroeconomic impact of financial development on exports, all industries together, was negative during the analyzed period.

## Table I: Financial constraints and the extensive margin

| Variables | $T_{ij,t}$ (Probit RE) | $T_{ij,t}$ (Probit PA) | $T_{ij,t}$ (Logit FE) |
|---|---|---|---|
| Private $_{i,t}$ | 0.207*** | 0.122*** | 0.059** |
| | (0.013) | (0.007) | (0.030) |
| Distance $_{ij}$ | -0.937*** | -0,549*** | |
| | (0.023) | (0.012) | |
| GDP $_{i,t}$ | 0.629*** | 0.352*** | -0.020 |
| | (0.010) | (0.006) | (0.048) |
| GDP $_{j,t}$ | 0.617*** | 0.348*** | 0.114** |
| | (0.009) | (0.005) | (0.048) |
| Population $_{i,t}$ | 0.100*** | 0.055*** | -1.710*** |
| | (0.013) | (0.007) | (0.194) |
| Population $_{j,t}$ | 0.019* | 0.016** | -1.648*** |
| | (0.012) | (0.007) | (0.191) |
| FTA $_{ij,t}$ | 0.410*** | 0.037 | 1.501*** |
| | (0.069) | (0.032) | (0.225) |
| WTO $_{ij,t}$ | 0.307*** | 0.192*** | 0.293*** |
| | (0.019) | (0.010) | (0.042) |
| Currency $_{ij,t}$ | 0.919*** | 0.699*** | 1.707*** |
| | (0.120) | (0.074) | (0.332) |
| Contig $_{ij}$ | -0.202 | -0.250*** | |
| | (0.156) | (0.085) | |
| Langue $_{ij}$ | 0.509*** | 0.277*** | |
| | (0.040) | (0.022) | |
| Colony $_{ij}$ | 2.149*** | 1.249*** | |
| | (0.490) | (0.338) | |
| SameCtry $_{ij}$ | 0.797*** | 0.305*** | |
| | (0.203) | (0.109) | |
| Landlock $_{ij}$ | -0.276*** | -0.178*** | |
| | (0.026) | (0.014) | |
| Island $_{ij}$ | 0.351*** | 0.232*** | |
| | (0.032) | (0.018) | |
| Time Fixed Effect | Yes | Yes | Yes |
| Country-pair Fixed Effect | Random | Non | Yes |
| Observations | 249 517 | 249 517 | 91 924 |

*** indicates the coefficient significance level at 1%, ** at 5% and * at 10%. Robust standard-errors are in parentheses Time and country-pair specific effect, as well as constant estimates not reported.

## Table II: Financial constraints and the intensive margin

| Variables | $x_{ij,t}$ OLS | $X_{ij,t}$ PPML | Polynomial $x_{ij,t}$ OLS | Polynomial $X_{ij,t}$ PPML |
|---|---|---|---|---|
| Private $_{i,t}$ | -0.070*** | -0.089*** | -0.070** | -0.093*** |
| | (0.019) | (0.029) | (0.019) | (0.029) |
| Distance $_{ij}$ | | -0,768*** | | -0,765*** |
| | | (0.010) | | (0.010) |
| GDP $_{i,t}$ | 0.244*** | 0.535*** | 0.246*** | 0.499*** |
| | (0.033) | (0.045) | (0.033) | (0.045) |
| GDP $_{j,t}$ | 0.563*** | 0.567*** | 0.564*** | 0.565*** |
| | (0.031) | (0.044) | (0.031) | (0.044) |
| Population $_{i,t}$ | -0.694*** | -0.287 | -0.671*** | -0.499** |
| | (0.152) | (0.218) | (0.152) | (0.221) |
| Population $_{j,t}$ | 0.625*** | -2.007*** | 0.616*** | -2.097*** |
| | (0.139) | (0.207) | (0.139) | (0.209) |
| FTA $_{ij,t}$ | 0.194*** | 0.374*** | 0.191*** | 0.376*** |
| | (0.023) | (0.019) | (0.023) | (0.019) |
| WTO $_{ij,t}$ | 0.321*** | 0.292*** | 0.320*** | 0.262*** |
| | (0.027) | (0.046) | (0.027) | (0.046) |
| Currency $_{ij,t}$ | 0.469*** | 0.009 | 0.464*** | 0.032 |
| | (0.118) | (0.024) | (0.118) | (0.024) |
| Contig $_{ij}$ | | 0.437*** | | 0.440*** |
| | | (0.019) | | (0.019) |
| Langue $_{ij}$ | | 0.233*** | | 0.232*** |
| | | (0.018) | | (0.018) |
| Colony $_{ij}$ | | 0.003 | | -0.000 |
| | | (0.061) | | (0.060) |
| SameCtry $_{ij}$ | | 0.096* | | 0.103** |
| | | (0.051) | | (0.051) |
| W $_{ij,t}$ | 0.020** | 0.078*** | | |
| | (0.009) | (0.013) | | |
| $\lambda(Z_{ij,t})$ | 0.359*** | | 4.737*** | |
| | (0.043) | | (1.501) | |
| $Z_{ij,t}$ | | | 3.058*** | -0.044 |
| | | | (1.046) | (0.044) |
| $(Z_{ij,t})^2$ | | | -0.871*** | 0.021 |
| | | | (0.302) | (0.029) |
| $(Z_{ij,t})^3$ | | | 0.082*** | 0.001 |
| | | | (0.029) | (0.004) |
| Time Fixed Effect | Yes | Yes | Yes | Yes |
| Country-pair Fixed Effect | Yes | Non | Yes | Non |
| Exp. Imp. Fixed Effect | Non | Yes | Non | Yes |
| Observations | 177 659 | 249 517 | 177 659 | 249 517 |

*** indicates the coefficient significance level at 1%, ** at 5% and * at 10%. Robust standard-errors are in parentheses (*cluster* and *robust* option were use in the estimate and the bootstrap method does not change the significance of the coefficients). Time, importer and exporter as well as country-pair specific effect estimates not reported. Constant term is also not reported.

# Robustness tables

## Table III: The independence of financial indicator

| Variables | OLS | PPML |
|---|---|---|
| Private $_{i,t}$ : | | |
| + Democracy $_{i1}$ | -0,066*** <br> (0,020) | -0,081*** <br> (0,029) |
| + Democracy $_{i2}$ | -0,066*** <br> (0,020) | - 0,082*** <br> (0,029) |
| + Policy $_i$ | -0,064*** <br> (0,020) | -0,082*** <br> (0,029) |
| + Durability $_i$ | -0,063*** <br> (0,020) | - 0,074*** <br> (0,029) |
| + Executive $_i$ | -0,064*** <br> (0,020) | - 0,083*** <br> (0,029) |
| + All $_i$ | -0,068*** <br> (0,020) | - 0,071*** <br> (0,029) |
| Time fixed effect | Yes | Yes |
| Country-pair fixed effect | Yes | Non |
| Imp. Exp.fixed effect | Non | Yes |

*** indicates the coefficient significance level at 1%, ** at 5% and * at 10%. Robust standard-errors are in parentheses. Time, importer and exporter as well as country-pair specific effect estimates not reported. Constant term is also not reported.

## Table IV: 3- 5- and 7- years moving average

| | OLS | PPML |
|---|---|---|
| Private $_i$ : 3 years moving-average | -0,110*** <br> (0,023) | -0,098*** <br> (0,036) |
| Private $_i$ : 5 years moving-average | -0,092*** <br> (0,030) | -0,095** <br> (0,045) |
| Private $_i$ : 7 years moving-average | -0,129*** <br> (0,043) | -0,088* <br> (0,068) |
| Time fixed effect | Yes | Yes |
| Country-pair fixed effect | Yes | Non |
| Imp. Exp.fixed effect | Non | Yes |

*** indicates the coefficient significance level at 1%, ** at 5% and * at 10%. Robust standard-errors are in parentheses. Time, importer and exporter as well as country-pair specific effect estimates not reported. Constant term is also not reported.

## Table V: Different financial indicators

| Variables | OLS | PPML |
|---|---|---|
| Bank $_{i,t}$ | -0,063* <br> (0,038) | 0,059 <br> (0,046) |
| Financial Depth $_{i,t}$ | 0,014 <br> (0,029) | 0,096* <br> (0,053) |
| Capitalization $_{i,t}$ | -0,002 <br> (0,011) | 0,067*** <br> (0,018) |
| Liquidity $_{i,t}$ | - 0,021*** <br> (0,007) | -0,053*** <br> (0,013) |
| Time fixed effect | Yes | Yes |
| Country-pair fixed effect | Yes | Non |
| Imp. Exp.fixed effect | Non | Yes |

*** indicates the coefficient significance level at 1%, ** at 5% and * at 10%. Robust standard-errors are in parentheses. Time, importer and exporter as well as country-pair specific effect estimates not reported. Constant term is also not reported.

## Table VI: The linearity of the financial effects on exports

| Variables | OLS | PPML |
|---|---|---|
| **Private $_{i,t}$ :** | | |
| High financially developed | -0,074*** <br> (0,021) | -0,143*** <br> (0,047) |
| Financially developed | -0,065*** <br> (0,023) | - 0,220*** <br> (0,057) |
| Average financially developed | -0,074*** <br> (0,025) | -0,117*** <br> (0,041) |
| Low financially developed | -0,085*** <br> (0,028) | - 0,059* <br> (0,036) |
| Non financially developed | -0,047 <br> (0,033) | - 0,028 <br> (0,036) |
| Time fixed effect | Yes | Yes |
| Country-pair fixed effect | Yes | Non |
| Imp. Exp.fixed effect | Non | Yes |
| Observations | 177 659 | 249 517 |

*** indicates the coefficient significance level at 1%, ** at 5% and * at 10%. Robust standard-errors are in parentheses. Time, importer and exporter as well as country-pair specific effect estimates not reported. Constant term is also not reported.

# References

Anderson, J. & Wincoop, E. V. (2003). Gravity with gravitas: a solution to the border puzzle. *American Economic Review*, 93, 170–192.

Baier, S. & Bergstrand, J. (2007). Do free trade agreements actually increase members' international trade? *Journal of International Economics.* 71(1), 72 – 95.

Beck, T. (2002). Financial development and international trade: is there a link? *Journal of International Economics.* 57, 107 – 131.

Beck, T. (2003). Financial dependence and international trade. *Review of International Economics.* 11(2), 296 – 316.

Beck, T., Demirguc-Kunt, A. & Levine, R. (2000). A new database on financial development and structure. *World Bank Economic Review.* 14, 597 – 605.

Berman, N. & Héricourt, J. (2010). Financial factors and margins of trade: Evidence from cross-country firm-level data. *Journal of Development Economics.* 93, 206 – 217.

Berthou, A. (2010). The distorted effect of financial development on international trade flows. CEPII Working Papers 2010 – 09.

Chaney, T. (2005). Liquidity constrained exporters. Technical Report, University of Chicago.

Chaney, T. (2008). Distorted gravity: The intensive and extensive margins of international trade. *American Economic Review*, 98(4):1707–21.

Das, M., Newey, W. & Vella, F. (2003). Nonparametric estimation of sample selection models. *Review of Economic Studies.* 70(1), 33 – 58.

Do, Q. & Levchenko, A. (2007). Comparative advantage, demand for external finance, and financial development. *Journal of Financial Economics*, vol. 86(3), 796-834.

Glick, R. & Rose, A. (2002). Does a currency union affect trade? The time-series evidence. *European Economic Review.* 46, 1125 – 1151.

Heckman, J. (1979). Sample selection bias as a specification error. *Econometrica.* 47, 153–161.

Helpman, E., Melitz, M. & Rubinstein, Y. (2008). Estimation trade flows: trading partners and trade volumes. *The Quarterly Journal of Economics.* 123 (2), 441-487.

Hur, J., Raj, M. & Riyanto, Y. E. (2006). Finance and trade: A cross-country empirical analysis on the impact of financial development and asset tangibility on international trade. *World Development.* 34 (10), 1728 – 1741.

King, R.G. & Levine, R. (1993). Finance and growth: Schumpeter might be right. *The Quarterly Journal of Economics.* 108(3), 717-738.

Kletzer, K. & Bardhan, P. (1987). Credit markets and patterns of international trade. *Journal of Development Economics*, 27, 57 – 70.

Levchenko, A. (2007). Institutional quality and international trade. *Review of Economic Studies*, 74(3), 791 – 819.

Levine, R. (2005). Finance and growth: theory and evidence. In P. Aghion & S. Durlauf (Ed.), Handbook of economic growth (Chapter 12). New York: Elsevier.

Manova, K. (2008). Credit constraints, heterogeneous firms and international trade. NBER Working Papers 14531.

Melitz, M. (2003). The impact of trade on intra-industry reallocations and aggregate industry productivity. *Econometrica*, 71 (6), 1695–1725.

Muûls, M. (2008). Exporters and credit constraints: a firm level approach. National Bank of Belgium Research Series 200809-22.

Rajan, R. & Zingales, L. (1998). Financial dependence and growth. *American Economic Review.* 88 (3), 559 – 586.

Rose, A. (2004). Do we really know that the WTO increases trade? *American Economic Review*. 94(1), 98 – 114.

Santos Silva, J. M. C. & Tenreyro, S. (2006) The log of gravity. *Review of Economics and Statistics.* 88, 641–658.

Santos Silva, J. M. C. & Tenreyro, S. (2009). Trading partners and trading volumes. Implementing the Helpman-Melitz-Rubinstein model empirically. Economics discussion papers 662, University of Essex, Department of Economics.

Svaleryd, H. & Vlachos, J. (2005). Financial markets, the pattern of industrial specialization and comparative advantage: Evidence from OECD countries. *European Economic Review*, 49, 113 – 144.

Wooldridge, J. (1995). Selection corrections for panel data models under conditional mean independence assumptions. *Journal of Econometrics*, 68(1), 115 – 132.