Financing Constraints, Firm Dynamics, Export Decisions, and Aggregate productivity

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Financing Constraints, Firm Dynamics, Export Decisions, and Aggregate productivity

Andrea Caggese[*]and Vicente Cuñat[†]

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Abstract

We develop a dynamic industry model where financing frictions affect the entry decisions of new firms in the home market, as well as the riskiness of operating firms. These two factors in turn determine a joint endogenous distribution of firms across productivity, volatility and financial wealth. We show that this endogenous distribution is crucial to understand export and productivity dynamics after a trade liberalization. In particular, the calibrated model predicts that financing frictions have an ambiguous effect on the number of firms starting to export. They reduce the ability of firms to finance the fixed costs necessary to start exporting, but they also change the distribution of domestic firms so that most of them find more profitable to access foreign markets. More importantly, the model predicts that financing constraints, even when they have a negligible net effect on the number of exporting firms, reduce the aggregate productivity gains induced by trade liberalization by 30% to 50%, because they distort the selection into export of the most productive firms. In the second part of the paper we verify the main predictions of the model with a rich dataset of Italian manufacturing firms for the period 1995-2003.

Keywords: Financing Constraints, Firm Dynamics, Exports, Productivity.

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1   Introduction

Becoming an exporter is an important decision for a firm. The literature on firms with heterogeneous productivity following Melitz (2003) emphasizes that this decision can be modelled as an investment decision, where the fixed costs of becoming an exporter have to be compared with the expected gains of accessing foreign markets for products. This view of the decision to export has proved quite successful empirically. At the same time, the effect of financing constraints on firm investment has been a recurrent topic in corporate finance. However the number of contributions that explore the decision to export in the presence of financing constraints is quite limited and generally restricted to static models. This paper intends to cover this gap by developing a dynamic industry model with heterogeneous firms where financing frictions and bankruptcy risk affect export dynamics both directly and indirectly, because they shape the selection into entry into the home market and therefore determine the cross sectional distribution of productivity and of risk of the domestic firms. Furthermore, this paper verifies empirically the predictions of the model with a large panel of Italian manufacturing firms for the period 1995-2003.

The theoretical part of the paper combines in a novel way three recent strands of literature. The trade literature that studies export dynamics with heterogeneous firms (following Melitz, 2003); the investment literature which has shown that firm investment decisions, and especially the timing of large fixed investments, are affected by the presence of borrowing constraints (see for example Whited, 2006); and the firm dynamics literature, which has recently emphasized the contribution of inter-firm reallocation on industry productivity and growth (see for example Hsieh and Klenow, 2009).

Even though this is not the first theoretical paper to embed financing constraints
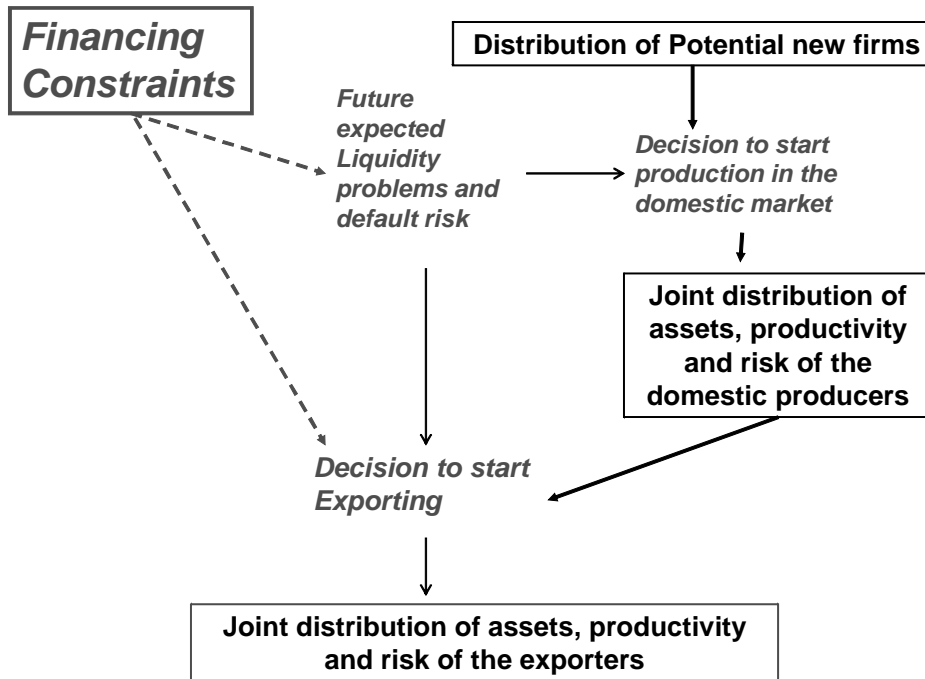
Figure 1:

into the Melitz model, one important novel element of our paper is the introduction of firm dynamics and costly bankruptcy.[1] The main effects of financing frictions in the model are illustrated in figure 1, which shows that financing frictions affect export decisions directly, because they prevent firms not having enough internal funds from paying the large fixed costs necessary to starting to export, but also indirectly, by affecting the selection into entry in the home market and the riskiness of operating firms. These two factors in turns determine a joint endogenous distribution of firms across productivity, volatility and financial wealth. This endogenous distribution is important to understand both firm level export decisions and their consequences for aggregate productivity after a trade liberalization.

The main empirical contribution of the paper is to test the predictions of the model.

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[1]See the next section for a review of the recent related literature.

To do so, we use self declared financing constraints and instrumental variables to avoid the endogeneity problems that arise from the codetermination of productivity and financing constraints.

In the model we consider firms that are heterogenous in their productivity and are subject to idiosyncratic shocks. They also face financing imperfections which limit their external financing, and therefore need to use internal funds to finance certain investment costs which are essential for their activity. As a consequence, if their liquid wealth is low, they may go bankrupt and be forced to liquidate their business after a negative shock, even though it would have been profitable to continue. Financing constraints and bankruptcy risk affect the distribution of firms in three different ways: first, they alter the entry decision of firms inducing a positive correlation between risk and return; second, bankruptcy affects the survival of firms, changing the pool of producers and the nature of competition; third, financing constraints affect directly the decision of becoming an exporter.

Firms can start exporting after paying a fixed cost. In the presence of financing constraints this fixed cost drains some liquid wealth and increases the risk of bankruptcy. In the absence of financing frictions, we obtain the standard result in Melitz (2003): only firms with productivity above a certain threshold are willing to start exporting, because the net present value of the profits from the exports is larger than the fixed cost involved in becoming an exporter. Therefore trade liberalization increases productivity because the most productive firms expand their activity by entering the export market, and because the increase in competition from foreign imports will push out of production the least productive ones.

Instead we show that in a calibrated industry affected by financing frictions (both in the home and in the foreign country), the productivity gains induced by trade liberalization are much smaller not because fewer firms export, but because the selection

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into export is distorted by the presence of financing frictions. More specifically, financing frictions have two important effects on industry dynamics and on the outcome of a trade liberalization.

First, the survival pattern of firms affects how their earnings evolve with time: financing frictions imply that new and young firms have some probability to default after a negative shock. This lowers their expected profits in the short run and deters entry. Therefore in equilibrium fewer entrants translate into a decrease in competition, and an increase in expected profits for the firms that survive and accumulate enough wealth to become financially unconstrained.

In other words, the age profile of expected profits in the financially constrained industry is more upward sloping. The default risk implies lower expected profits at young age, that are compensated by reduced competition and higher profits for the firms that "survive" their early age and accumulate enough wealth to be covered against future default risk. These higher profits benefit low risk firms, which face little default risk when young, because their income process is not very volatile. Therefore some low risk/low productivity firms which would not start production in a perfect markets industry, find it profitable both to start production and to start exporting after a trade liberalization in an industry with financing frictions.

Second, the presence of financial frictions generates a risk vs. return trade off that affects the selection of firms into entry: firms learn about the riskiness of their business at the beginning of their life. Higher risk involves a higher likelihood of experiencing large negative shocks that lead them to bankruptcy, and a lower chance of surviving the initial stages of their activity. Therefore new firms that operate a very risky technology will stay in business only if their productivity is very high. Conversely, some low productivity/low risk firms will stay in business because their lower risk also reduces their bankruptcy probability. This endogenous correlation amplifies the effect of financing

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constraints, as very productive firms are also on average riskier, and therefore more affected by financing frictions when deciding on becoming exporters. The endogenous selection of firms into the home market implies that the most productive firms in the industry are also on average riskier and will find it optimal to delay entering in foreign markets until they have accumulated a sufficient amount of precautionary wealth.

We quantify these effects by calibrating an artificial industry whose dynamics match those of our sample of Italian manufacturing firms. We show that, with respect to a financially unconstrained industry, the presence of financing constraints and bankruptcy risk reduces the productivity gains following a trade liberalization by 30% to 50%. However, the number of firms that export in the constrained and unconstrained industry is very similar. The difference in industry productivity is entirely due to the worsening of the selection into home production and into export induced by financing constraints.

In the empirical section of the paper we provide evidence of these effects using a rich dataset of Italian manufacturing firms for the period 1995-2003. This dataset contains precise information on the trade policies of firms and on their self-declared financing constraints. While this information on financing constraints is particularly detailed, there is still the possibility that confounding effects such as productivity shocks that are not fully captured by the productivity measures could be driving both exports and financing constraints. To avoid this endogeneity problem we use standard measures of credit availability commonly used in the relationship lending literature as instrumental variables.

Our empirical results show that: first, the distribution of productivity in the sample is consistent with the presence of financing constraints and entry costs in the form of initial investments. Second, financing constraints are an important determinant of the exporting decision of the firm, and their effect is quantitatively as important as other

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effects identified in the literature such as size and productivity. Third, consistently with the behavior predicted by the model, the amount of liquid assets held by the firms around the time when they begin exporting is positively correlated with productivity for firms that face financing frictions, while they are not correlated with productivity for the financially unconstrained firms. Finally, we show empirically that a proxy of the productivity of the firms becomes a worse predictor of its exporting behavior the larger the financing constraints. For firms that are ex-ante less likely to be financially constrained, productivity is a good predictor of their export behavior, while for firms that are more likely to be constrained its predictive power falls.

The paper is organized as follow: Section 2 reviews the related literature; Section 3 illustrates the model; Section 4 describes the simulation results; Section 5 describes the empirical evidence and finally Section 6 concludes.

2   Literature

The model is related to an extensive literature on firm-level export decisions started by Melitz (2003). A sustained assumption of the models in this literature is that firms are heterogeneous in their productivity levels and decide to become exporters by paying a fixed initial cost. The role of financing constraints in the context of this family of models has been explored by Chaney (2005) by introducing exogenous financing constraints as an additional source of heterogeneity across firms. In Chaney (2005) firms need cash in advance to pay for the fixed costs of exporting and some of them are exogenously financially constrained. Financially constrained firms never export and this, in turn, generates reallocation effects that are different from the standard model without financing constraints. Manova (2008) extends this framework by partially endogenizing financing constraints. Firms are allowed to borrow a proportion of next-period's production. The degree of financing frictions that a firm faces is therefore modelled as the

proportion of next year's production that can be borrowed this year. The risk of going bankrupt plays an important role in our model, and a related argument can be found in Garcia Vega and Guariglia (2007), who modify the Melitz (2003) model to introduce idiosyncratic volatility and financing constraints. More recently, models with financing frictions and exports have been studied by Mayneris (2010) and Berman and Hericourt (2010).

All these models nicely embed financing constraints into the standard Melitz model. However one important novel element of our paper is the introduction of firm dynamics. All the above papers study "static" industries, in the sense that firms are not allowed to retain earnings and to change their capital structure in response to financing frictions. Conversely our paper studies a fully dynamic industry where the joint distribution of firms across productivity, volatility and wealth arises endogenously. We show that this endogenous distribution is very important to understand both firm level export decisions and their consequences for aggregate dynamics after a trade liberalization.

Empirically, a number of recent papers have explored the impact of financing constraints on exports. Manova (2008, 2010) shows how country-sector measures of financing constraints are negatively correlated with exports. Muuls (2008), Mayneris (2010), Berman and Hericourt (2010) and Bellone *et al.* (2010) study the relation between financing constraints and export using firm level financing constraints variables. Greenaway *et al.* (2007) show that seasoned exporters exhibit better financial wealth than non exporters; while this is not true about recent exporters. This result lends support to the idea of large fixed costs associated with entering foreign markets. Garcia-Vega and Guariglia (2007) test their model on a sample of UK firms and show that volatility in productivity may reduce the likelihood of becoming an exporter. All of these papers, with the exception of Manova (2007,2008) use financing constraints measures that are constructed using balance sheet information. The advantage of these

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measures is that they use very standard information so they can be applied to large samples. However these measures are correlated with productivity shocks and hard to instrument. If productivity is measured with some error, the financing constraints measures are likely to capture part of the effect of productivity even in a setup where they do not matter.

Another related paper is Minetti and Chun Zhu (2010), who use a subset of the database of Italian firms we employ in this paper to analyze the effect of financing frictions on the intensive and extensive margins of export. Beside using a larger dataset, our empirical analysis differs from Minetti and Chun Zhu (2010) in that we test the specific predictions of our dynamic model regarding the direct and indirect implications of financing frictions for the distribution of wealth and for the productivity-export relation.[2]

3   The Model

We consider an industry where heterogenous firms are allowed to produce at home and to export in a foreign market. The objective of the model is to study how financing frictions affect the selection of firms into production, and to study the joint effect of these frictions and of the steady state distribution of firms on the export decisions and productivity dynamics in the industry.

We follow Melitz (2003) and Costantini and Melitz (2007) and consider a model where each firm in an industry produces a variety w of a consumption good. There is a continuum of varieties $w \in \Omega$. Consumers preferences for the varieties in the industry

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[2]Other papers that do not focus on financing constraints but are nonetheless related are Campa and Shaver (2001) and Castellani (2002). Campa and Shaver (2001) show that exporting firms may use the exposure to different countries to diversify the risk of business cycle fluctuations. This can be seen as a reverse causality result that shows that becoming an exporter may ease financing constraints in the long run. Castellani (2002) studies the same database analysed in this paper, and shows that labour productivity growth variables affect the likelihood of exports. However the levels of labour productivity do not seem to be related to the decision to export.

are C.E.S. with elasticity $\sigma > 1$. The C.E.S. price index P_t is then equal to:

$$P_t = \left[\int_w p_t(w)^{1-\sigma} \right]^{\frac{1}{1-\sigma}} \tag{1}$$

And the associated quantity of the aggregated differentiated good Q_t is:

$$Q_t = \left[\int_w q_t(w)^{\frac{\sigma-1}{\sigma}} \right]^{\frac{\sigma}{\sigma-1}} \tag{2}$$

where $p_t(w)$ and $q_t(w)$ are the price and quantity consumed of the individual varieties w, respectively. The overall demand for the differentiated good Q_t is generated by:

$$Q_t = AP_t^{1-\eta} \tag{3}$$

where A is an exogenous demand parameter and $\eta < \sigma$ is the industry price elasticity of demand. From (2) and (3) the demand for an individual variety w is:

$$q_t(w) = A\frac{P_t^{\sigma-\eta}}{p_t(w)^{\sigma}} \tag{4}$$

Each variety is produced by a firm using labour (where units of labour are defined such that wage cost $=1$). The productivity parameter ν determines the marginal cost of production, which is equal to $1/\nu$. The profits from the domestic activity of a firm with productivity ν, and variety w are given by:[3]

$$\pi_t^D(\nu, \varepsilon_t) = p_t(w)q_t(w) - \frac{q_t(w)}{\nu} - F_t \tag{5}$$

Where $F_t > 0$ are the overhead fixed costs of production that have to be paid every period. They are subject to an idiosyncratic shock ε_t, which follows an AR(1) process with mean zero, volatility σ_ε^2 and autocorrelation coefficient ρ_ε:

$$F_t = F + \varepsilon_t \tag{6}$$

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[3] In order to simplify the notation, in this section we refer to a generic firm, and therefore we do not add any sub-index for firm specific parameters such as v, a and X.

Firms are heterogeneous in terms of productivity ν and the volatility of the fixed production cost σ_ε^2. The determination of ν and σ_ε^2 across firms is explained in section 3.2. The shock ε_t introduces uncertainty in profits, and it plays an important role in the presence of financing frictions. By affecting the probability of default, the shock also affects both the entry decision and the export decision of firms. The idiosyncratic shock enters additively in $\pi_t^D(\nu, \varepsilon_t)$ so that it does not affect the firm decision on the optimal price p_t and quantity produced q_t.[4] The firm is risk neutral and chooses p_t, after observing ε_t, in order to maximize $\pi_t^D(\nu, \varepsilon_t)$. The first order condition yields the standard Melitz pricing function:

$$p_t = \frac{\sigma}{\sigma - 1} \frac{1}{\nu} \tag{7}$$

It then follows that:

$$\pi_t(\nu, \varepsilon_t) = \frac{(\sigma - 1)^{\sigma-1}}{\sigma^\sigma} A P^{\sigma-\eta} \nu^{\sigma-1} - F_t$$

As in Melitz (2003), firms are allowed to export. They have to pay a per unit variable trade cost τ_t, a per period fixed cost to export F_t^X. When a firms exports for the first time it also has to pay an initial sunk cost S^X. Assuming that we are in a symmetric two country world, it is easy to show that profits from export are as follows:

$$\pi_t^X(\nu, \varepsilon_t) = \frac{(\sigma - 1)^{\sigma-1}}{\sigma^\sigma} A P^{\sigma-\eta} \left(\frac{\nu}{\tau_t}\right)^{\sigma-1} - F_t^X$$

$$F_t^X = F^X + \varepsilon_t^X$$

The shock ε_t^X follows an AR(1) process with mean zero, volatility $\sigma_{\varepsilon^X}^2$, autocorrelation coefficient ρ_{ε^X}, and it is possibly contemporaneously correlated with ε_t.

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[4]A multiplicative shock of the type $\varepsilon_t p_t(w) q_t(w)$ would not change the qualitative results of the model, but it would have two main consequences. First, it would imply that the optimal quantity produced $q_t(w)$ would be a function of the intensity of financing frictions, thus making the solution of the problem both more complicate and less comparable to the benchmark Melitz model. Second, it would imply that expected profits are a function of σ_ε^2.

The timing of the model for a firm which was already in operation in period $t-1$ is the following. At the beginning of period t its technology may become "useless" with an exogenous probability $\delta < 1$. In this case the firm ends its activity and liquidates its assets.[5] With probability $1 - \delta$ the firm continues activity, and its financial wealth a_t is determined as follows:

$$a_t = R(a_{t-1} - S^X I^X_{t-1} + \pi^D_{t-1}(v) + X_{t-1}\pi^X_{t-1}(\nu)) \tag{8}$$

where I^X_{t-1} is equal to one if the firm decided in period $t-1$ to pay the fixed cost S^X in order to start exporting in period t. X_t is an indicator function that is equal to one if the firm is an exporter in period t.[6]

Equation (8) implies that the firm pays no dividends and that all revenues are reinvested in the business. In other words, dividends are distributed only once the firm stops its activity and liquidates its assets. Since we assume that the firm is risk neutral, and that it discounts future profits at the real interest rate R, the decision not to distribute dividends is optimal when the firm faces financing frictions. When the firm accumulates enough wealth to become financially unconstrained, it also becomes indifferent about distributing or retaining earnings. Therefore this assumption does not limit the analysis in any important way.

At the beginning of period t the firm observes the realization of the shocks to the fixed costs of producing and exporting ε_t and ε^X_t, which determine $\pi^D_t(\nu, \varepsilon_t)$ and $\pi^F_t(\nu, \varepsilon_t)$, the profits which will be generated during this period. Financing frictions are introduced by assuming that the firm cannot borrow to finance the fixed cost of its operations. While it can pay workers with the stream of revenues generated by their

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[5] This exogenous exit is necessary to calibrate an industry with a stationary distribution of firms.

[6] This happens when $X_{t-1} = 1$ and the firm decided to continue exporting, or when $X_{t-1} = 0$ but $I^X_{t-1} = 1$. Conversely, X_t is equal to zero either if the firm was a domestic producer ($X_{t-1} = 0$) and decided to continue only in the domestic market, or if the firm was an exporter ($X_{t-1} = 1$) and decided to stop exporting (no fixed costs are associated to this decision).

labour input, it has to pay in advance the per period fixed costs of production:

$$a_t \geq F_t + X_t F^X + S^X I_t^X \tag{9}$$

If the constraint (9) cannot be satisfied, then the firm cannot continue its activity and is forced to liquidate. In order to interpret this condition, it is important to remember that X_t is decided in period $t-1$ and is therefore a state variable at time t. It indicates that the firm is an exporter in the current period. Conversely, I_t^X is a choice variable in period t. Therefore, the following cases are possible:

The firm is not currently an exporter $(X_t = 0)$
$$\begin{cases} a_t \geq F_t + S^X : \text{the firm can continue domestic activity and could start exporting} \\\\ F_t \leq a_t < F_t + S^X : \begin{array}{l} \text{the firm can continue domestic production but does not} \\ \text{have enough funds to start exporting} \end{array} \\\\ a_t < F_t : \text{the firm is forced to liquidate} \end{cases}$$

The firm is currently an exporter $(X_t = 1)$
$$\begin{cases} a_t \geq F_t + F^X : \quad \text{the firm can continue domestic and foreign production} \\\\ a_t < F_t + F^X : \quad \text{the firm is forced to liquidate} \end{cases}$$

Constraint (9) is a simple way to introduce financing frictions in the model. Moreover it generates realistic firm dynamics, and can be interpreted as a shortcut for more realistic models of firm dynamics with financing frictions.[7] The limitation of this assumption is that it imposes that financing frictions do not affect the investment in variable inputs of the firm. However this limitation is justified by one considerable advantage: together with the assumption of the linearity of the profits shock (see equation 6), it keeps the model considerably easier to solve and more comparable to the basic Melitz (2003)

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[7]For instance, Clementi and Hopenhayn (2006) derive the optimal long term bank-firm contract under asymmetric information. They show that under the optimal contract firms are initially financially constrained. But if successful they gradually grow and become unconstrained. However, if unsuccessful they may go bankrupt even though their projects are profitable. Moreover, they also show that even with a i.i.d. shock to firm revenues, the model generates persistence and path dependence in firm dynamics. We will show later in this section that the constraint (9) generates firm dynamics similar to those in Clementi and Hopenhayn (2006).

model. Moreover, to use a more realistic financing frictions assumption is not likely to change the main results of the model. This is because, as it will be explained later, the liquidation risk implies that firms accumulate a precautionary stock of liquid assets before starting to export. Therefore, if we assumed that also variable production inputs were subject to financing frictions, the production decisions of exporting firms would not be likely to change because these precautionary assets would be large enough to allow the self financing of all variable inputs.

3.1 Export decision

If the firm has enough resources to satisfy constraint (9), then it has to decide about the next period's production. In order to characterize this decision, we define $V_t^0\left(a_t, \varepsilon_t \mid v\right)$ as the value of the firm (defined as the net present value of the future expected profits) conditional on $X_{t+1} = 0$ (no export status in period $t+1$), and we define as $V_t^1\left(a_t, \varepsilon_t \mid v\right)$ the value of the firm conditional on $X_{t+1} = 1$.

$$V_t^0\left(a_t, \varepsilon_t \mid v\right) = \frac{1-\delta}{R} E_t\left[V_{t+1}^D\left(a_{t+1}, \varepsilon_{t+1} \mid v\right)\right] \tag{10}$$

$$V_t^1\left(a_t, \varepsilon_t \mid v\right) = \frac{1-\delta}{R} E_t\left[V_{t+1}^X\left(a_{t+1}, \varepsilon_{t+1} \mid v\right)\right] \tag{11}$$

In the following analysis and in the benchmark calibration we make the simplifying assumption that the shock to home and export production are perfectly correlated: $\varepsilon_t = \varepsilon_t^X$. We later show that the results of the model are confirmed even if ε_t and ε_t^X are uncorrelated. The decision concerning X_{t+1} depends on the initial status. If a firm is not currently an exporter, it will start exporting if $V_t^1\left(a_t - S^X, \varepsilon_t\right) - S^X > V_t^0\left(a_t, \varepsilon_t\right)$. Conversely a firm which is already exporting will keep exporting if $V_t^1\left(a_t, \varepsilon_t\right) > V_t^0\left(a_t, \varepsilon_t\right)$. As a consequence $V_t^D\left(a_t, \varepsilon_t \mid v\right)$, the value of a firm that starts period t without an exporter status, is:

$$V_t^D\left(a_t, \varepsilon_t \mid v\right) = 1\left(a_t \geq F_t\right)\left\{\pi_t^D\left(\varepsilon_t, v\right) + \max\left[V_t^1\left(a_t - S^X, \varepsilon_t \mid v\right) - S^X, V_t^0\left(a_t, \varepsilon_t \mid v\right)\right]\right\}$$

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and the value of a firm which start period t with an exporter status is

$$V_t^X \left(a_t, \varepsilon_t \mid v\right) = 1 \left(a_t \geq F_t + F_t^X\right) \left\{\pi_t^D \left(\varepsilon_t, v\right) + \pi_t^X \left(\varepsilon_t, v\right) + \max \left[V_t^1 \left(a_t, \varepsilon_t \mid v\right), V_t^0 \left(a_t, \varepsilon_t \mid v\right)\right]\right\}$$

The term $1\left(.\right)$ is an indicator function which is equal to one if the financing constraint is satisfied, and is equal to zero otherwise.

3.2   Entry decision

Every period there is free entry. New entrants start with the same initial wealth a_0, and have to pay an initial cost S^C to "constitute the firm". This can be interpreted as a research and development cost to determine the characteristics of the product the firm will produce and sell. After paying this cost, the firm observes its type $(v, \sigma_\varepsilon^2)$, which is drawn from an initial distribution. At this point, the firm decides whether to pay a fixed cost S^B to start the actual production process. We assume, for simplicity, that the firm always starts production in the home country only. The firm will decide to start production if the product is profitable:

$$V^D \left(a_0, v \mid \sigma_\varepsilon^2\right) - S^B > 0 \tag{12}$$

The free entry condition requires that ex ante the expected value of paying S^C and constituting a firm is zero. Assuming that v is uniformly distributed among the set of discrete values $\{v_1, ..., v_N\}$, and σ_ε^2 is uniformly distributed among the set of discrete values $\left\{\sigma_{\varepsilon_1}^2, ..., \sigma_{\varepsilon_M}^2\right\}$, and that the two distributions are independent, the free entry condition can be written as follows:

$$\frac{\sum_{j=1}^N \sum_{i=1}^M \max \left\{V^D \left(a_0, v_j \mid \sigma_{\varepsilon_i}^2\right) - S^B, 0\right\}}{NM} - S^C = 0 \tag{13}$$

The choice of distinguishing between two different types of initial fixed costs is new (to our knowledge) in this literature, and it requires some explanation. Beside being

realistic to distinguish between the startup costs to define the product and the costs to actually start producing it, this definition allows to analyze the selection role of financing imperfections. The pre-entry cost S^C is the one that determines the amount of potential entrants, while S^B determines the characteristics of entrants. We show that given a draw of v and σ_ε^2 the value of entering the market $V^D\left(a_0, v \mid \sigma_\varepsilon^2\right)$ decreases in σ_ε^2 in the presence of financing frictions, because the higher is σ_ε^2, the more volatile are profits, and the higher is the risk that the firm will hit a binding constraint (9) and be liquidated. Since $V^D\left(a_0, v \mid \sigma_\varepsilon^2\right)$ also increases in v, it follows that financing frictions generate an endogenous positive correlation between idiosyncratic risk and productivity. This positive correlation, of which we find strong evidence in the data, has important consequences for the effect of financing frictions on export dynamics, as it will be shown below.

3.3 Industry equilibrium

We consider a steady state industry equilibrium where the aggregate price P_t, the aggregate quantity Q_t, and the distribution of firms over the values of v, a_t and σ_ε^2 are constant over time. The presence of the exogenous exit probability δ ensures that the distribution of wealth across firms is non-degenerate. Aggregate price P_t is set to ensure that the free entry condition (13) is satisfied. The number of firms in equilibrium ensures that P_t also satisfies the aggregate price equation (1). Aggregation is very simple because, as in Melitz (2003), all operating firms with productivity ν choose the same price $p_t(\nu)$, as determined by (7).

4 Model's solution and calibration

The solution of the model is obtained using a numerical method (see Appendix I for a description). The time period is one year, and the benchmark parameters are as

follows: the aggregate productivity term A matches the number of firms in the empirical dataset analyzed in the next section. The exit probability δ is set to 0.04, matching the average exit rate of firms observed in the empirical data. The real interest rate r is set equal to 2%. Following Constantini and Melitz (2007) the fixed costs F is calibrated so that firms on average devote 20% of their labour cost to overhead. F^X is set equal to F.

The technological parameters v, σ_ε^2 and ρ_ε match the firm dynamics estimated using our dataset of Italian manufacturing firms. The uniform distribution of $v \in [\underline{v}, \overline{v}]$ matches the cross sectional distribution of the profits/sales ratio. The distribution of the volatility of the shock σ_ε^2 is uniform between 0 and $\overline{\sigma}_\varepsilon^2$, where $\overline{\sigma}_\varepsilon^2$ is chosen to match the average coefficient of variation of the profits/sales ratio at the firm level. The autocorrelation coefficient ρ_ε matches the autocorrelation of the profits/sales ratio. The fixed export cost S^X corresponds to a sunk cost of starting to export equal to 25% of average yearly sales in the industry. This is in line with Das, Roberts, and Tybout (2007), who estimate for Colombian chemical plants that export penetration costs account for between 18.4 and 41.2 percent of the annual value of a firm's exports. The startup cost S^C matches the average profitability of firms; the fixed cost of starting production S^B affects the selection into entry and the relation between risk and volatility of new firms. Therefore it is chosen in order to match the difference in the correlation between volatility and profits between constrained and unconstrained firms.[8]

The variable trade cost τ matches the fraction of exporting firms for which exports account for at least 20% of total sales.[9] The value of initial wealth a_0 determines the

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[8]For both the empirical and the simulated correlations we consider time series of 9 observations for each firm.

[9]The threshold of 20% does not affect the simulated statistics, because all simulated firms that start exporting do indeed export a large fraction of their total production. It is instead important for the empirical data, where some firms may export small quantities simply because they are using

intensity of financing frictions and the probability of bankruptcy for young firms. It is calibrated in order to match the fraction of financially constrained firms.[10] Among the parameters that we do not directly calibrate, the elasticities σ and η are taken from Melitz and Costantini (2007), and ε^X is assumed to be perfectly correlated to ε.[11]

-table 1 about here-

Table 1 summarizes the calibrated parameters and the matched moments. The parameter values match the chosen moments reasonably well. In particular, the simulated firms are very similar to those in the dataset concerning the level, volatility and cross sectional dispersion of profits. Moreover in the simulated dataset on average 0.36% of firms default every period because of a binding liquidity constraint (9). This is of a similar order of magnitude of the frequency of yearly defaults observed for manufacturing firms (around 0.5%-1%). The simulated data are also consistent with the stylized fact that the exit rate of firms is age dependent. The exit rate of firms in the first year of age is 9%, in the second year is 5.5%, in the third year is 4.8% and then it gradually converges to the constant exogenous exit rate of 4%. The simulated data also matches well the fraction of exporting Italian firms. More than 50% of the firms in the sample export a substantial amount of their products in our sample. On the one hand, this empirical fact depends on two features of the Italian industry: i) the presence of a large number of small firms specialised in producing and exporting high quality manufactured goods; ii) the high level of trade integration of North Italy (where are located around 90% of all the Italian manufacturing firms) with Continental

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indirect channels and they did not invest the sunk cost to establish a proper presence in the foreign markets.

[10] In the empirical dataset we detect on average 14% of firms that every period complain about the lack of external finance availability. In the simulated data, for the firms that continue activity, the only financially constrained investment is the export decision. Firms cannot borrow, and therefore in order to be able to continue activity in period t, and to start exporting in period $t+1$, their wealth w_t need to cover both the fixed cost F_t and the sunk cost S^X.

[11] This perfect correlation assumption simplifies the numerical solution of the model, but it is not essential for the results.

Europe. On the other hand, the main results of the model still hold for alternative calibrations with a much smaller fraction of exporting firms, as it will be shown later in table 4.

4.1 Simulations results

Figure 2 shows the value function $V(a_t \mid \nu, \sigma_\varepsilon^2)$ of two representative firms with the same productivity ν but with different risk levels σ_ε^2. For simplicity we consider the case in which the shock ε_t is serially uncorrelated ($\rho_\varepsilon = 0$). For this figure we chose the minimum productivity level ν such that a financially unconstrained firm finds it optimal to start exporting. On the X axis is the value of the firm's assets a_t as a fraction of average sales in the industry. The figure also shows the export decisions of both firms. The value function is concave in wealth for the high risk firm because, when assets a_t are low, the firm is unable to finance fixed costs after a negative shock and is forced to exit. These costs are much higher for the high risk firm. When assets are large, the probability of "going bankrupt" disappears, and the two firms have the same value.[12]

-Figure 2 about here-

Figure 2 also shows that the export decision depends on wealth. The low risk firm does not export when its wealth is very low, because it does not have enough wealth to pay for the export cost S^X even when bankruptcy is not an issue. Therefore we denote this interval as the "binding constraint region". Conversely, the high risk firm starts exporting only when wealth is very high. This firm faces an higher volatility of profits. For intermediate values of wealth it would have enough resources to pay for S^X, but such cost would reduce a_t and would leave the firm much poorer and more financially

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[12]The value function measures only the future expected profits, and it does not include also the value of the assets represented on the X axis.

fragile. Thus this high risk firm prefers to wait and to accumulate more assets, for precautionary reasons, before starting to export. Therefore the wealth interval in which only the low risk firm exports identifies the "precautionary region". In this particular case the value function is virtually flat for assets values in the precautionary region because the chosen value of ν implies that the net present value of starting to export is very small for these firms.

Figure 3 compares the same low risk firm shown in figure 2 with a higher productivity and higher volatility firm. This comparison is important, since idiosyncratic risk and productivity are positively correlated across firms in the simulated industry because of the selection effect induced by financing frictions and entry costs. Figure 3 shows that the high productivity firm has higher value, but also that its value is more sensitive to financial wealth. This firm also engages in precautionary saving to reduce future financing problems, and therefore it chooses to accumulate an higher amount of wealth than the less productive firms before starting to export. This precautionary effect is important since exporting is very profitable for this firm and the delay implies a loss in terms of lower expected net income. This loss is reflected in the fact that the value function for the high risk/high productivity firm is now upward sloping in the precautionary region.

-Figure 3 about here-

This precautionary effect has also important consequences for aggregate productivity. More productive firms fear bankruptcy more, because the wedge between their expected discounted profits and their liquidation value is higher. This effect is reinforced by the fact that more productive firms are on average more volatile; so they need to accumulate more wealth before starting to export. In other words, the more firms in an industry are subject to financing frictions, the more is likely that we observe a less

productive firm which chooses to start exporting while a more productive one chooses to wait. At the aggregate level, this reduces the beneficial effect of trade liberalization on the reallocation of production.

In order to quantify the aggregate effect of financing frictions on firm dynamics after trade liberalization we simulate several calibrated artificial industries for many periods, and we compute their steady state statistics. We consider three different industries: one with perfect financial markets, and no financing frictions; one with financing frictions but no default risk, and one with both financing frictions and default risk. These three industries are identical in terms of all the parameters illustrated before, except the following: in the "Financing frictions only" industry the profits shock is equal to zero, $\varepsilon_t = 0$ for any t. This industry is similar to those analyzed by Manova (2008) and Chaney (2005). Profits are not volatile, but some firms do not export because they have insufficient internal funds to finance the export cost S^X. In the "perfect markets" industry instead initial wealth a_0 is high enough so that no firm is ever financially constrained in its investment decisions, regardless of its volatility σ_ε^2. Therefore firm dynamics in this industry are the same as in the standard Melitz model.

Figure 4 compares the allocation of capital in the three industries before opening up to trade, and the selection into export after trade liberalization. The three bottom lines refer to the distribution of productivity of firms operating in the home market, when trade is not allowed. In the "perfect markets industry" there is a simple productivity threshold as in the standard Melitz model. New firms that draw a productivity value ν above a certain minimum level $\nu^{\min}$ pay the sunk cost S^B and begin production, while firms below that level do not. The industry with financing frictions and no risk is identical to the "perfect market industry", because by construction the export cost S^X is the only investment subject to financing constraints in this industry.[13]

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[13] This is because, in the absence of risk, if a_0 guarantees that the financing constraint (9) does not

-Figure 4 about here-

On the contrary, in the industry with financing constraints and risk there is much more dispersion of productivity across operating firms, which implies a lower aggregate productivity relative to the other two industries. This result can be understood as a combination of several effects. First, there is a "selection" effect. Firms that pay the setup cost S^C and find out to be high risk, will pay S^B and start production only if they are very productive. This generates a positive correlation between idiosyncratic risk and productivity among operating firms, and it implies that some medium productivity firms that operate in the perfect markets industry do not operate here because their income process is too volatile and the default risk too high. Second, there is a "competition" effect. Firms in this industry face some probability of inefficient default in the early stage of their lives. This discourages entry, reduces competition, and increases expected profits until firms find it profitable again to enter. In other words, the expected profits in the industry are upward sloping. Lower profits expected at young age, because of the default risk, are compensated by reduced competition and higher profits for the firms that "survive" their early age and accumulate enough wealth not to face any default risk in the future. These higher profits are very attractive for low risk firms, which do not face any default risk when young, because their income process is not very volatile. Therefore some low risk/low productivity firms which do not start production in the perfect markets industry find it profitable to start production in the "default risk" industry. Third, there is the "exit" effect. Among the high productivity firms, there are many risky firms that exit in the first years of life because of liquidity problems after receiving a negative shock.

Therefore figure 4 implies that the allocation of capital among firms in a closed

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bind in period 1 for an home producing firm, it also guarantees that it does not bind in any future period.

economy is worsened by financing frictions and default risk. The remaining three "circled" lines in figure 4 represent the distribution of exporting firms when the industry opens up to trade.[14] By construction the vertical distance between the "active firms" line and the "exporters" line measures the positive reallocation effect induced by the selection into export. The larger the distance, the more export activity is concentrated among the more productive firms, and the more liberalizing trade promotes a reallocation of production towards the more productive firms.[15] Figure 4 shows that such distance is much smaller in the financially constrained industry, showing that financing frictions worsen the selection into export. In other words, in the presence of default risk productivity becomes less important in determining the decision to export, and therefore trade liberalization has a smaller impact on the reallocation of capital than in the "perfect markets" industry.

This result is also best explained by distinguishing several effects: first, there is a direct effect. Only firms that accumulate enough wealth to pay the sunk cost S^X may start exporting. This effect actually increases the importance of productivity for the export decision, because more productive firms accumulate wealth faster on average. However, the selection effect and the competition effect mentioned before worsen the selection into export. According to the selection effect, more productive firms are on average more risky, and need to accumulate more financial wealth before starting to export. According to the competition effect, some low risk/low productivity firms, which would only operate in the home market in the absence of financing frictions, find it profitable to export in the industry with default risk, due to the higher profits

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[14]Each industry opens up to trade in a symmetric two country world, where the foreign country industry shares the same characteristics.

[15]The total effect of trade liberalization on productivity is given by this reallocation effect, weighted by the number of exporting firms, and by the competition effect that pushes out of production some firms that were previously operating in the home market. This latter effect is not shown in figure 4, but is analysed more in details in tables 2-4.

enjoyed by the firms that do not default. Figure 4 also shows that the selection into export in the industry with "financing frictions only", where there is no default risk, no selection effect, and a very small competition effect, is very similar to the selection in the perfect markets industry.

-Figure 5 about here-

Figure 4 jointly analyze the impact of the selection and competition effects on export decision, while figures 5 and 6 focus on the former one. Figure 5 shows the accumulation of financial assets for firms grouped according to the parameter σ_ε^2 (the volatility of profits). In the industry "with financing frictions only" firms do not go bankrupt, and they accumulate exactly the amount of assets necessary to finance the sunk cost to start exporting. The volatility of profits has no effect on the export decision in this industry. Conversely in the industry with default risk the higher is the volatility of profits, the higher are average profits, because of the selection effect, but also the higher are the assets accumulated before starting to export. The difference in the accumulation of assets between the two industries is entirely due to precautionary saving. Figure 6 shows that such precautionary behavior significantly increases the time necessary to start exporting for the most volatile firms. Firms that discover to be high risk enter into production only if they are very productive, and then they wait much longer before starting to export than the less productive and volatile firms.

-Figure 6 about here-

The implications of figures 4-6 is that the gain in aggregate productivity from liberalizing trade may be significantly smaller in the presence of financing frictions not because fewer firms export, but because selection into export is not efficient. This prediction of the model is quantified in table 2. In the first three columns we compare the same three industries analyzed in figure 4. The first row shows the percentage of

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exporting firms. In the "financing frictions only" economy 36.6% of firms export, versus a value of 49.9% in the "perfect markets" economy. This difference is due to the firms that cannot pay for the sunk cost S^X when their wealth a_t is too low. Conversely the percentage of exporting firms is much higher in the "default risk" economy, being equal to 48%. Here the direct negative effect is also operational, but it is counterbalanced by the general equilibrium effect mentioned before, which has a positive effect on the probability to export. The second row of table 2 shows the gain in productivity caused by trade liberalization. The percentage value is measured relative to the productivity in the "default risk" industry before opening up to trade. Moreover it is standardized so that a 100% value would imply that after trade liberalization all production is carried out by the firms with the highest productivity in the distribution $\overline{v}$. The figure shows that the gain in productivity is more than 30% smaller in the "Default risk" industry with respect to the "Perfect markets" industry. This reduction is not caused by a reduction in the number of exporting firms, which is approximately equal in the two industries. Instead it is due to a worsening in the selection of firms into home production, and to a worsening of the selection of firms into export. On the contrary the reduction in productivity gains is much smaller in the "financing frictions only" industry, despite fewer firms export here, because selection into export is as good as in the perfect markets economy.

-Table 2 about here-

These results imply that financing frictions may significantly affect firm dynamics after a trade liberalization not simply because firms are unable to export, as it has been suggested by the previous literature, but because they worsen the selection both into home and into foreign markets. We show that this selection effect is quantitatively important in affecting the productivity gains from trade liberalization. One possi-

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ble objection of this result is that access to foreign markets may actually reduce the volatility of profit by diversifying the revenues shocks (see Campa and Shaver 2001). We consider this possibility in the fourth column of table 2, which assumes that revenues from export are not subject to uncertainty ($\varepsilon_t^X = 0$ always). Therefore exporting reduces the volatility of profits in relative terms, and this reduction is larger the riskier a firm is. This is of course an extreme example, because in reality it is plausible to assume that ε_t^X and ε_t^X have a certain degree of positive correlation. Nonetheless table 2 shows that, even when export is not risky, the default risk substantially reduces the increase in average productivity caused by trade liberalization. This is because the competition effect described before is still present, since it is determined by the risk of entering in the home production. Moreover the selection effect becomes less strong, but it does not disappear completely.

4.2 Sensitivity analysis

Tables 3 and 4 analyze the robustness of the results illustrated in the previous sections for different calibrations.

-Table 3 about here-

Table 3 shows industry dynamics in the "default risk" industry with alternative calibrations of the volatility parameter $\overline{\sigma}_\varepsilon^2$, the initial wealth a_0 and the persistency parameter ρ_ε. These three parameters affect the wealth distribution, and change industry dynamics only in the industry with financing frictions, because wealth is irrelevant for the production decisions of firms in the perfect markets industry. Among the results shown in table 3, it is worth noting that the general result of a smaller increase in productivity holds across all the specifications. However, when financing frictions are less strong because volatility of profits is smaller ($\overline{\sigma}_\varepsilon^2 = 0.5$) or because initial wealth is larger ($a_0 = 0.32$), then the worse reallocation of capital is almost entirely due to the

worse selection into export market. This reallocation is particularly inefficient when persistency is high. A value of $\rho_\varepsilon = 0.8$, which is not implausible, given that it generates an autocorrelation of the profits sales ratio around 0.4, implies that selection into export generates an increase in productivity as little as 3.1%.

-Table 4 about here-

Table 4 analyses how the results vary for different values of the sunk cost S^X of starting to export. It shows that both the percentage of exporting firms and the increase in productivity are very sensitive to S^X in the perfect markets economy, as originally emphasizes by Melitz (2003). Conversely in the default risk economy we see two important differences. First, the selection and competition effects makes the percentage of exporting firms less sensitive to S^X. Indeed when S^X is high the percentage of exporting firms is higher in the industry with financing frictions than in the perfect markets one. Second, the increase in productivity is almost insensitive to changes is S^X, because when S^X is low and many firms export the selection into export becomes relatively worse, and is not compensated by a larger increase in the selection into home production.

5 Empirical Evidence

There are four main predictions of the model that are tested throughout this section:

Prediction 1: Productivity and the volatility of productivity should be correlated and this correlation is higher for financially constrained firms.

Prediction 2: Financing constraints should affect the decision of becoming an exporter even after controlling for productivity.

The reason is that financing constraints affect the ability of the firm to pay the fixed costs of exporting and therefore even if financing constraints are not caused by

productivity they should still matter in determining the firm's exporting behavior.

Prediction 3: Financially constrained firms should hoard liquidity around the moment when they become exporters, for precautionary reasons.

While financially unconstrained firms can borrow to pay for the large initial fixed costs of exporting, financially constrained firms will accumulate enough liquid assets so that even after paying for the initial export costs they will have enough resources to face future demand shocks in both the home and the export market. Furthermore, productivity affects this precautionary liquidity hoarding in two ways: it tends to reduce it because more productive firms expect on average to accumulate wealth faster once they start exporting. But also it tends to increase it because productive firms are also riskier, and hence need more liquidity to absorb bigger shocks. If the second effect prevails (as it does in the calibrated simulated industries analyzed in the previous section), then the liquidity hoarding should be stronger for more productive firms.

Prediction 4: The effect of the firm's individual productivity on the likelihood of being an exporter should be smaller the higher the financing constraints.

While in an unconstrained industry a strict threshold of productivity should determine whether a firm exports or not, this threshold gets blurred the moment financing constraints appear. On the one hand some high risk/high productivity firms prefer to delay the export decision, on the other hand some low productivity/low risk firms are more likely to continue operating in both the home and foreign market. The intuition for this result is captured in figures 3 and 4.

5.1   Data Description

To test the empirical predictions of the model we use the dataset of the Mediocredito Centrale surveys. The dataset contains a representative sample of Small and Medium Italian manufacturing firms. It is an incomplete panel with two main sources of infor-

mation gathered in two different surveys:

i) Balance sheet data and profit and loss statements from 1995 to 2003 at a year level (index t).

ii) Qualitative information from three surveys conducted in 1997, 2000, 2003. Each survey (indexed j) reports information about the activity of the firm in the three previous years and in particular, it includes detailed information on exports and financing constraints.

Each survey is conducted on a representative sample of the population of small and medium manufacturing firms (smaller than 500 employees). The samples are selected balancing the criterion of representativeness with the one of continuity. The firms in each survey contain three consecutive years of data. After the third year 2/3 of the sample is replaced and the new sample is then kept for the three following years.

This dataset is particularly well suited for our analysis. It contains firm-level detailed information about financing constraints, information about the exporting behavior of the firm and standard accounting data. Once we restrict ourselves to the observations with valid information the relevant variables the dataset contains 6966 firms and 31939 firm-year observations.

The firm-level variables about international trade that we use in the analysis are: A dummy variable that measures whether the firm exports part of its production (*export dummy$_j$*), the % of sales exported (*% sales exported$_j$*) and the number of regions to which the firm exports out of a maximum of 8 different international regions (*number of regions$_j$*).[16] [17]

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[16]The regions are EU, Africa, Asia, China, USA-Canada, Central and South America, Oceania, Other.

[17]In most of the regressions throughout the paper there is not enough within firm variation to justify the use of fixed effects regressions. The reasons for this are that 2/3 of the sample is replaced in each 3 year wave, that some variables do not change buy construction throughout the 3 years window and that there is substantial persistence in both trade and financing constraints variables.

As our main measure of financing constraints we consider the questions in the Survey where each firm is asked:

i) Whether it had a loan application turned down recently.

ii) Whether it desires more credit at the market interest rate.

iii) Whether it would be willing to pay an higher interest rate than the market rate in order to obtain credit.

We use this information to construct our main measure of financing constraints $constrained_{ij}$, which takes value 1 for period j if firm i answers yes to any of the questions (i) to (iii) and takes value zero otherwise. According to this measure 14% of the firms declare to be financially constrained. This is a much more reliable measure of financing constraints than measures based on balance sheet information or financial outcomes. However a possible concern is that this variable could be correlated with productivity shocks which are likely determinants of trade outcomes. For this reason we use an instrumental variables approach using as IVs variables that are unlikely to be correlated with productivity shocks.

In all the regressions we introduce as controls the size of the firm measured as the log of its real total assets (*Log real total assets$_{it}$*), the age of the firm in years (*Age (years)$_{it}$*) and age squared (*Age squared$_{it}$*) and the productivity level of the firm (*TFP$_{it}$*). Productivity is measured as the residual from a regression model in which total production is explained by a translog specification of a Cobb Douglas production model that includes fixed capital and total employment. The coefficients of the model are allowed to vary at a 2 digit-sector level and on 3 year windows.[18] This measure of productivity is quite standard in the empirical literature. Furthermore, Crino and Epifani (2010) use the Mediocredito dataset to study how firm and foreign market

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[18]In particular productivity is measured by ϵ_{it} in the following model $log(y_{it}) = \sum_{j=1}^{S} \sum_{s=1}^{S} \alpha_{sj} \log(K_{it}) + \beta_{sj} \log(L_{it}) + \gamma_{sj} \log(K_{it}) * \log(L_{it}) + \eta_s + \mu_t + \epsilon_{it}$
w where s referes to 2 digit sector levels, j to 3 year intervals and t to the years 1995 to 2003.

characteristics affect the geographic distribution of exporters' sales. They calculate several measures of total factor productivity and show that the results based on a Cobb-Douglas translog specification are similar to the results based on alternative measures of productivity, such as a Cobb-Douglas specification with the semiparametric estimators proposed by Olley and Pakes (OP, 1996) and Levinsohn and Petrin (2003). Furthermore, it is important to note that our theoretical model is very stylized, and not entirely consistent with using a standard TFP measure as a proxy of productivity. We pick this particular measure for consistency and comparability with the existing literature. The results are however robust to using a productivity measure based on gross profits (sales minus variable costs) which is entirely consistent with the model.

5.2   Identification strategy

Both exports and financing constraints are likely to be correlated with the levels of productivity of the firm. Given that our productivity measure is an imperfect proxy for true productivity it would be possible that the measure of financing constraints would be partially capturing the effect of productivity. That is, if productivity is correlated with exports and our productivity proxy measures it with error, the financing constraints measure may also be proxying for productivity. For this reason we need to instrument our financing constraints measure with instrumental variables that are uncorrelated with productivity shocks and unlikely to affect exports through channels other than financing constraints.

We use a set of instrumental variables similar to the ones used in Caggese and Cuñat (2008). A first approach uses as instrumental variable that measures the level of financial development at a regional level ($Financ.\ Dev_i$). This variable is calculated in Guiso, Sapienza and Zingales (2004) and it measures the likelihood that a consumer bank loan is denied in different Italian regions. The measured is "inverted" and nor-

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malized, so that a value of zero indicates the highest probability of denial and that the maximum possible value is 0.56. While this variable is uncorrelated with temporary liquidity shocks that the firm may have, it is possible that, cross sectionally, it is correlated with variables that jointly determine financing constraints and the propensity to export. For this reason we use a second set of instruments that are based on the relationship lending literature. These variables are the share the main lending bank has over the total loans of the firm ($Percentage\ loans\ with\ main\ bank_{ij}$), the number of years that the firm has been operating with this bank ($length\ of\ main\ bank\ relationship_{ij}$) and the square of this same variable ($length\ of\ main\ bank\ relationship\ squared_{ij}$). This set of instruments is referred to as $Rel\ lending\ IV$ in the regressions.

Table 5 justifies the validity of these variables as instruments of financing constraints and shows the first stage of the IV regressions.

-table 5 about here-

In column 1 we pool all four variables and add some balance sheet variables that are correlated with financing constraints. These are the leverage ratio of the firm ($Leverage\ ratio_{it}$), its net financial assets over total assets ($Liquidity\ ratio_{it}$) and the coverage ratio ($Coverage\ ratio_{it}$). This is a form of validation of our measure of financial constraints that is correlated with balance sheet measures of constraints. With respect to the instrumental variables, the table shows that higher financial development reduces the likelihood of being financially constrained. A larger share of loans with the main bank is however related to higher financing constraints. This has been identified in the relationship lending literature as a consequence of higher monopoly power of the bank. Longer relationship with the main bank reduces the likelihood of being financially constrained in a convex way. Columns 2 and 3 show the first stage regressions of the two sets of instrumental variables.

5.3 Results

In Table 6 we verify the first prediction of the model, showing the relationship between firm productivity and its volatility. The measure of firm productivity is the TFP variable described in section 5.1. The measure of volatility in columns 1 to 3 is the firm-level standard deviation of this same measure and we interact it with dummies that correspond to the firms in the top and middle third of predicted financing constraints according to the first stage regression in Table 6 column 3 (i.e. using the instruments share main$_{ij}$, bank years$_{ij}$, bank years2$_{ij}$). More specifically, we first predict the variable everconstrained$_{ij}$ using our instrumental variables. The variable is averaged at a firm level and used to generate three dummy variables $highconstrained_i$, $midconstrained_i$, and $lowconstrained_i$ that split the sample in roughly three equal parts (with $lowconstrained_i$ being the omitted variable in the regressions) according to the predicted financing constraints of the firm. The variables are then interacted with the volatility of the productivity of the firm. The correlation between the predicted financing constraints and the productivity measure is 0.009. This is not surprising, given the way that they are constructed but it is important to emphasize it, as the interacted variables should represent comparable populations of firms in terms of productivity but with different levels of financing constraints. Column 3 includes controls for log assets, age, age squared, year, sector and regional dummies.

-table6 about here-

The results in columns 1 to 3 show that indeed, productivity is correlated with its volatility and that this correlation is higher for those firms that are more constrained. In columns 4 to 6 we replicate the analysis but using the standard deviation of productivity divided by log net sales to measure volatility. This alternative measure is a unit independent measure of volatility and therefore less sensitive to the influence

of the size of firms in determining volatility.[19] This is a much more strict test of the correlation between productivity and its volatility and, in fact, the model does not predict that this ratio is necessarily growing on productivity; this is only the case when selection into entry is quite strong. The results are however quite similar to the ones in columns 1 and 2 showing that the volatility of productivity is positively correlated with productivity but that the effect is mainly coming from financially constrained firms.

Table 7 verifies the second prediction of the model, showing the basic results of the influence of financing constraints on the exporting policies of firms. The main control variables replicate some of the results already present in the literature. Larger sizes and higher productivity levels are associated with a higher likelihood of exporting, higher proportion of exports and more destination regions. Age is also positively correlated with the likelihood of being an exporter in general and in particular markets; however age does not seem to have much impact on the intensive margin of exports.

-table 7 about here-

The main results of this table are the ones on the financing constraints variable. Constrained firms are less likely to export when financing constraints are instrumented (columns 2 and 3). This is an important result. Even after controlling for productivity, size, age, sector and year effects, financing constraints still retain power in explaining exports. This effect is unlikely to be the result of financing constraints capturing a productivity residual, given the nature of our instrumental variables.[20] Interestingly, financing constraints do not seem to affect the percentage of sales exported (columns

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[19]Note that an alternative unit-independent measure is the coefficient of variation of TFP (i.e. sdTFP/meanTFP), but given that the average TFP is by construction zero at a sector-period level, the coefficient of variation leads to frequent outliers in this case.

[20]The results are consistent with Manova (2008) and Muûls and Pisu (2009) that show that measures of financing constraints based on balance sheed and sector data are negatively correlated with exports. However a general theme in both papers is that financing constraints are largely determined by productivity. From an identification point of view, it is difficult to disentangle what part of their results is due to direct or indirect effects of productivity. Our instrumental variables approach is unlikely to be capturing productivity effects on the constraints measure.

4 to 6). This is consistent with the idea that financing constraints are relevant for the fixed costs of exporting, but less relevant on the intensive margin, where the exported goods can serve as collateral and international trade credit is generally available.[21] Importantly, it is also consistent with the prediction of the model that firms start to export only after they accumulated some financial assets for precautionary reasons, in order to reduce future financing problems. Finally (in columns 7 to 9), financing constraints also affect negatively the number of international regions to which the firm exports. This last effect seems quite strong and may be related to the existence of fixed exporting costs that are region-specific (e.g. having a firm representative in each region or adapting goods to regional tastes).

The next set of results verify the third prediction of the model by showing the evolution of liquidity when firms become exporters. In table 8 the dependent variable is a measure of liquidity constructed as total cash and liquid assets over total assets ($liquidity_{it}$). We then identify the 4 years prior and including the moment in which the firm went from being a non exporting firm to start exporting and construct a dummy variable ($start\ exporting_{it}$) that takes value 1 for these years and zero otherwise.

-table 8 about here-

Column 1 of Table 8 shows the results of a basic regression. Larger, older and exporting firms tend to have lower liquidity levels. Around the event of becoming exporters firms seem to have lower liquidity levels. To test the prediction of the model that financially constrained firms should hoard liquidity when they start exporting, we split the sample into those firms with high expected financing constraints (above average) and those with low expected constraints. Expected financing constraints are

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[21]Minetti and Chun Zhu (2010) use a subset of our dataset and find some impact of financing constraints on the log of total exports. This is a related measure of intensive margin of exports, the main difference being that our measure is unaffected by the size of the firm.

constructed using a regression that uses our second set of IVs. That is, we use our measure of predicted financing constraints, where the predictors are the relationship lending variables ($share\ main_{ij}$, $bank\ years_{ij}$, $bank\ years2_{ij}$). The results of these two regressions can be seen in columns 2 and 3 of Table 8. The set of firms that are more financially constrained do actually hoard liquidity around the export event, with respect to the set of firms that are unconstrained that reduce their levels of liquidity. Both the behavior of constrained and unconstrained firms is consistent with the predictions of the model. Furthermore, in columns 4 to 6 we add a dummy variable that takes value one when firms' productivity is above their sector average and zero otherwise. Column 4 shows that more productive firms tend to accumulate more liquidity around the export event. Importantly, Columns 5 and 6 imply that this liquidity hoarding of more productive firms around the time they start to export is entirely driven by the most constrained firms in the sample, as predicted in the model.

The next set of regressions aims to test one of the main predictions of the model. In a standard Melitz model there is a sharp distinction between exporting and non exporting firms in terms of productivity. However, in our model, the presence of financing constraints blurs this relationship. As seen in Section 4, a regression of the export status of the firm on its productivity should have lower coefficients as financing constraints become more intense. Furthermore, the higher the intensity of financing constraints the lower the predictive power of firm productivity on exports. To test this prediction we use the predicted $constrained_{ij}$ variable as in table 6 to generate dummy variables $highconstrained_i$, $midconstrained_i$ accounting for the top and middle third of firms in terms of predicted financing constraints. We run regressions in which the export status variables are regressed against the interacted variables, the raw dummies and the same set of controls used throughout the paper.

-Table 9 about here-

The results can be seen in Table 9. As shown in column 1, the coefficient of productivity on the export status of the firm becomes smaller as financing constraints become tighter starting with a positive coefficient and ending with an insignificant one for the most constrained firms (i.e. the composition of the coefficients of *TFP* and *highconstrained x TFP*). Columns 2 shows the same pattern but in this case it applies to the percentage of sales devoted to exports. Productivity seems to be an important determinant of the percentage of exports for firms with good access to credit. However it seems to have no effect on those firm with mild or severe financing constraints. Column 3 shows the results with respect to the number of regions to which the firm exports. The results in columns 3 show again that the effect of productivity on exports decreases with financing constraints.

These empirical results, together with the theoretical results shown before, prove that the presence of financing constraints increases the heterogeneity in terms of productivity within exporting and non-exporting firms. In turn, the differences between a representative exporting and a representative non-exporting firm are reduced. Financing constraints can therefore help to explain the relatively low differences in size between exporting and non-exporting firms, which cannot be easily explained by the standard Melitz model.

6 Conclusions

We present and test empirically a model in which firms face constraints in financing their fixed operational costs and the one-off costs associated with becoming an exporter. The capital structure and the financial constraints faced by the firms are determined endogenously, given the investment decisions of the firms and their idio-

syncratic demand shocks. Financially constrained firms, which would become exporters in an unconstrained model, may postpone the decision to export in foreign markets because the fixed costs associated to export may increase their bankruptcy risk. This mechanism operates even when financing constraints are not currently binding. Higher productivity has two effects on this decision. On the one hand it makes becoming an exporter more profitable, as in standard firm models following Melitz (2003). On the other hand, more productive firms are also on average riskier, and face an higher probability of bankruptcy after they pay the fixed costs of exporting. From a purely theoretical point of view the composition of these two effects is ambiguous, however a calibrated model shows that the second effect dominates and that financially constrained firms accumulate more financial wealth before starting to export when they are more productive. This effect is also present in the empirical part of the paper. Financially constrained firms hoard more liquidity around the event of becoming an exporter. More productive firms hold in general less liquidity around it but this effect is not present for financially constrained ones.

The model shows that, in equilibrium, financing frictions reduce the aggregate productivity gains induced by trade liberalization. This happens not because fewer firms export, but because the selection into export is severely distorted by the presence of financing frictions. Even though more productive firms will tend to be the ones who export in the long run, the productivity threshold between exporting and non-exporting firms gets blurred in the short-run when firms are financially constrained. As a consequence, the predictive power of productivity in terms of determining exports gets reduced whenever a substantial amount of firms faces financial constraints. This is also confirmed empirically. In the first generation of models of firm-level export decisions productivity tends to be the sole determinant of firms' exporting policies. This normally leads to very stark size differences between exporting and non-exporting firms that is

not supported by the empirical facts. One way to reconcile these results is to introduce some heterogeneity across firms in fixed or variable costs (Armenter and Koren, 2009). This model contributes to this debate by showing that financing constraints increase the heterogeneity within exporting and non-exporting firms in terms of productivity, thus making the size difference between exporters and non-exporters smaller.

Finally, two important policy implications can be drawn from this paper. First, if an aggregate financial shock hits, leading to lower access to credit for all firms, this will affect the composition of exporting and non-exporting firms in the future. In particular the positive effects of trade in terms of allocating production to the most productive set of firms will be attenuated whenever access to credit is scarce. Second, when a country opens up to trade, the effects will be most beneficial in those sectors with better access to financial markets. Those with poor access will not be able to take advantage of the opening to trade and may in fact face higher risk of bankruptcy.

7   Acknowledgements

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8 Appendix I

In order to obtain a numerical solution for the value functions $V_t^D \left(a_t, \varepsilon_t \mid v, \sigma_\varepsilon^2, P \right)$ and $V_t^X \left(a_t, \varepsilon_t \mid v, \sigma_\varepsilon^2, P \right)$, we consider values of a_t in the interval between 0 and $\overline{a}_t$, where $\overline{a}_t$ is a sufficiently high level of assets such that the firm is never financially constrained now or in the future. We then discretise this interval in a grid of 800 points. The shock ε_t is modeled as a two state symmetric Markov process. the supports $[\underline{v}, \overline{v}]$ and $[0, \overline{\sigma}_\varepsilon^2]$ are discretized in grids of 61 points and 12 points respectively. We make several experiments with these grid dimensions to be sure that these values are large enough so that the choice of the grid does not significantly influence the quantitative results of the simulations.

We first make an initial guess of the equilibrium aggregate price P. Based on this guess we calculate the optimal value of $V_t^D \left(a_t, \varepsilon_t \mid v, \sigma_\varepsilon^2, P \right)$ using an iterative procedure. We then apply the zero profits condition (13) and we update the guess of P accordingly. We repeat this procedure until the solution converges to the equilibrium. Then we simulate an artificial industry where every period the total number of new entrants ensures that condition (1) is satisfied.

9   Figures and Tables

Figure 2: Value (left scale) and decision to export (right scale) of firms with same productivity and different risk levels
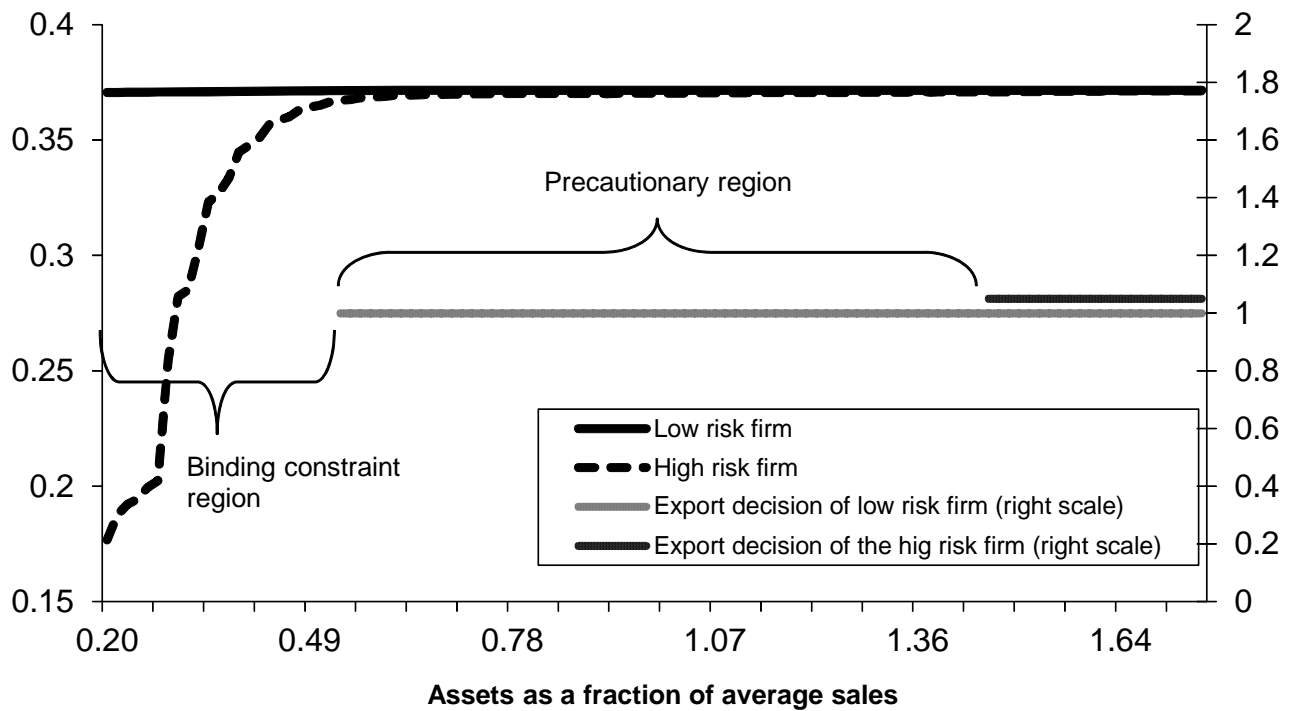
Figure 3: Comparison between a low productivity/low risk and a high productivity
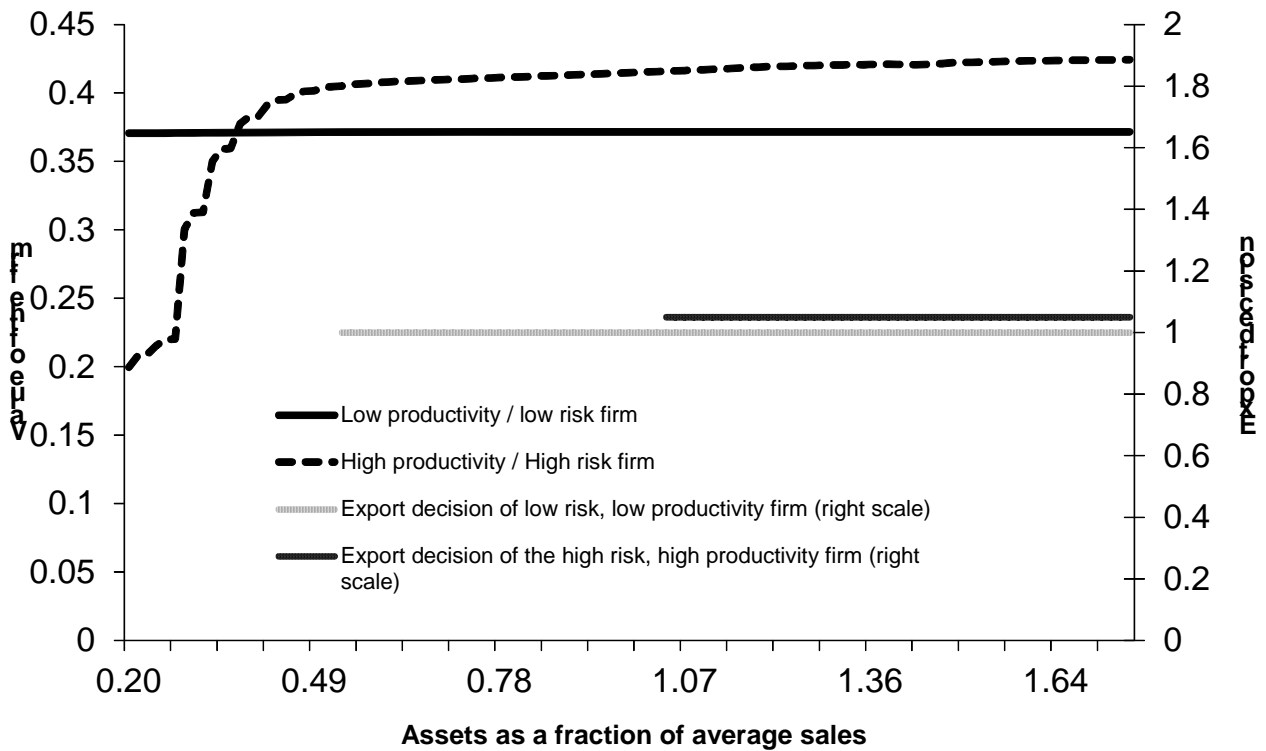
Figure 4: Percentage of firms over productivity levels
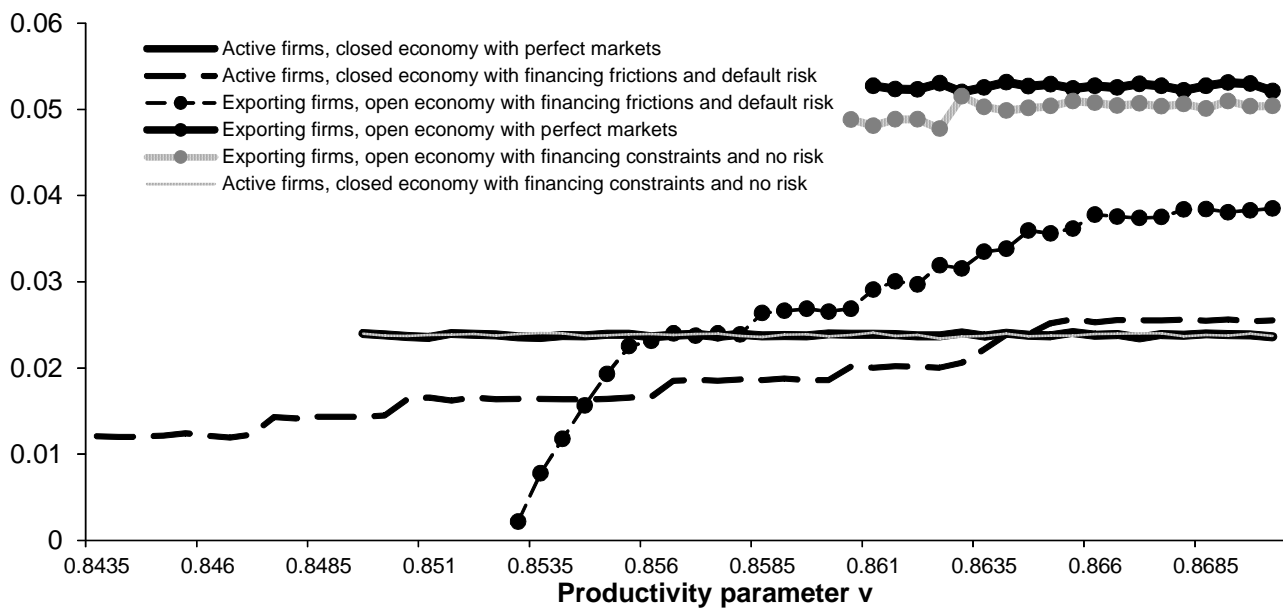
Figure 5: Precautionary saving for firms with different volatility of profits

Volatility of profits

Legend:
- Average financial assets of firms that start to export (industry with default risk, left scale)
- Average financial assets of firms that start to export (industry with financing frictions only, left scale)
- Average profits (industry with default risk, right scale)
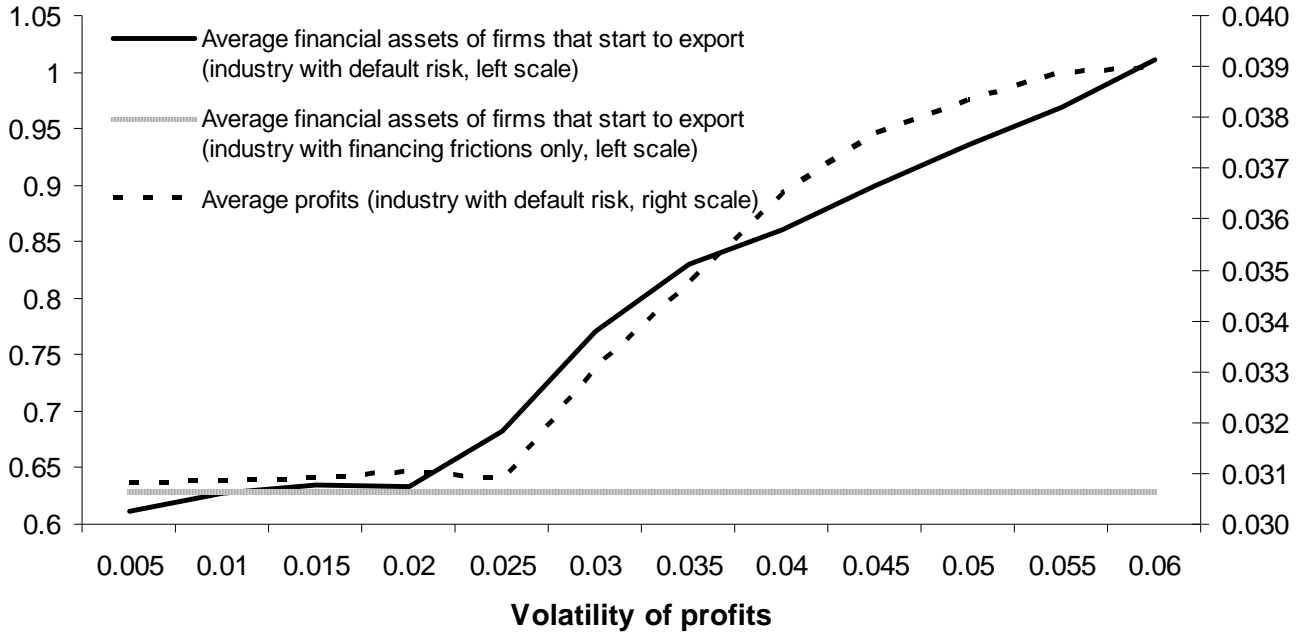
Figure 6: Average age of firms that start to export

Average age of a firm that starts to export (industry with default risk)

Weighted average age of a firm that starts to export (industry with default risk)

Average age of a firm that starts to export (industry with financing frictions only)

Volatility of profits
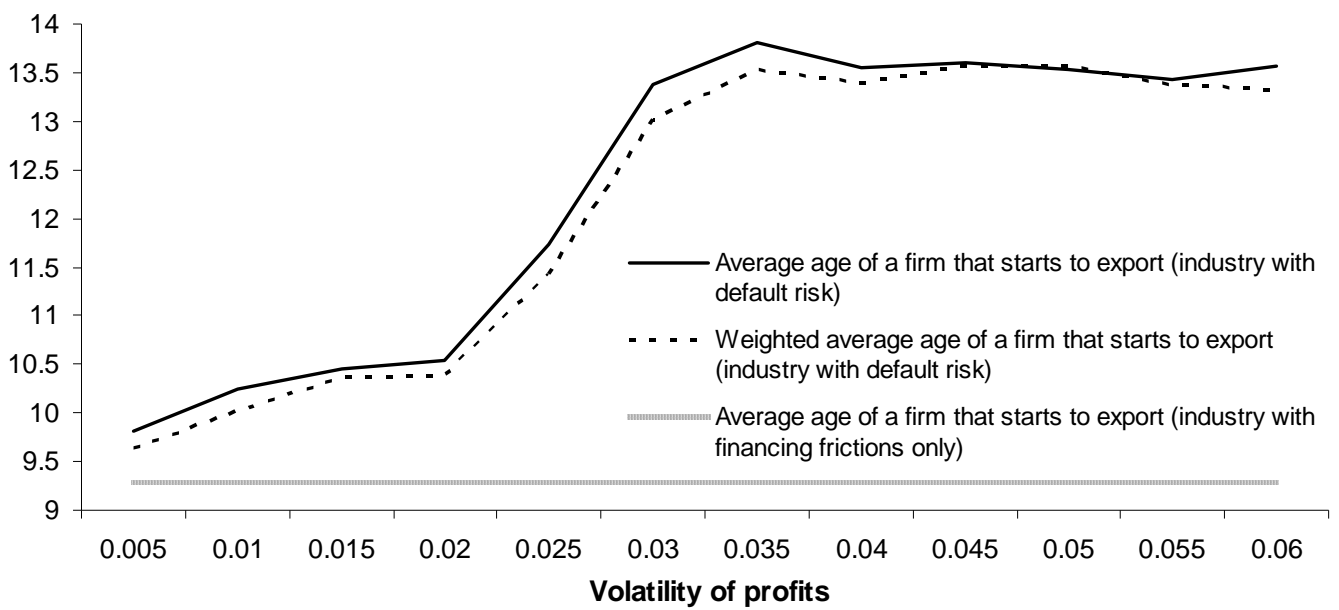
Table 1: Calibration

Matched parameters				
	Value	Moment to match	**Data**	**Baseline simulation**
A	2010	number of firms	13.000	13.000
δ	0.04	Average age of firms	25	25
r	1.02	average real interest rate	2%	2%
F	14%*	average ratio fixed costs/labour costs	0.20	0.20
S^X	25%*	Cost of starting to export	20-40%	25%
v	[0.862;0.895]	cross sectional volatility of π/y	0.018	0.023
$\overline{\sigma}_\varepsilon^2$	0.6	avg. coeff. of var. of π/y (time series)	1.07	1.03
ρ_ε	0.4	Autocorrelation of π/y	0.21	0.20
S^C	7%*	average of π/wl	0.059	0.061
S^B	42%*	difference in corr(sd(π/y), mean(π/y))	0.15	0.1
τ	1.05	fraction of firms exporting $\geq 20\%$ sales	50%	48%
a_0	27%*	fraction of financially constrained firms	14%**	21%***
Other parameters				
η	1.5	From Costantini and Melitz (2007)		
σ	4	From Costantini and Melitz (2007)		
F^X		same as F		
ε_t^X		Perfectly correlated to ε_t.		
Other moments				
		fraction of firms going bankrupt	0.5-1%	0.36%

** Firms that declare financing problems.

*** Firms with not enough financial wealth to start exporting ($w_t < S^X + F_t$)

Table 2: Increase in productivity after a trade liberalisation, in different industries

	Perfect markets	Financing frictions	F.frict. and Default risk	F.frictions Def. risk, but "safe exports"[1]
% of exporting firms	49.9%	36.6%	48%	48.2%
% change in avg. prod.[2]	**32.6%**	**27.9%**	**20.5%**	**21.9%**
Composition				
Selection into home market	18.7%	16.6%	11.9%	10.6%
Selection into export	13.9%	14.0%[3]	8.8%[3]	11.2%[3]
correct for % of export firms	0	-2.7%[4]	-0.2%[4]	-0.3%[4]

[1] In this industry export is not risky, because $\varepsilon_t^X = 0$ for any t

[2] Computed as a % of the maximum reallocation possible. 100% would imply that after trade liberalization all the production is carried out by the firms with the highest productivity $\overline{\nu}$

[3] This value measures the increase in average productivity that would be caused by the selection into export if there were as many exporting firms as in the "perfect markets" industry

[4] This value measures the increase in average productivity that is indirectly caused by the percentage of exporting firms relative to the "perfect markets" industry

Table 3: Increase in productivity after a trade liberalisation: sensitivity analysis for the parameters affecting wealth distribution

	Perfect markets	Default risk						
		Base**	$\overline{\sigma}_\varepsilon^2$		a_0		ρ_ε	
			0.5	0.7	0.22	0.32	0	0.8
% exporting	49.9%	48%	43%	50%	49%	46%	42%	52%
% increase prod.*	32.6%	20.5%	26.7%	15.3%	17%	23%	23%	17.1%
Selection home	18.7%	11.9%	17.5%	6.7%	7.8%	14%	12.6%	14%
Select. export	13.9%	8.8%	9.2%	8.7%	9.3%	9.3%	10%	3.1%
% exporting	0	-0.2%	-1.1%	-0.01%	-0.2%	-0.5%	-1.2%	0.01%

*computed as a % of the maximum reallocation possible. 100% would imply that after trade liberalization all the production is carried out by the firms with the highest productivity $\overline{\nu}$

** Base calibration: $\overline{\sigma}_\varepsilon^2 = 0.6$; $a_0 = 27$; $\rho = 0.4$

Table 4: Increase in productivity after a trade liberalisation: sensitivity analysis to the cost of starting to export

	$S^X = 0.16$		$S^X = 0.2$(base cal.)		$S^X = 0.24$	
	perfect markets	default risk	perfect markets	default risk	perfect markets	default risk
% exporting	79%	62%	49.9%	48%	22%	33%
% increase prod.*	34%	20%	32.6%	20.5%	25%	18.3%
Selection home	27.7%	17.3%	18.7%	11.9%	12.3%	6.0%
Select. export	6.8%	3.2%	13.9%	8.8%	12.7%	8.9%
% exporting	0%	-0.5%	0%	-0.2%	0%	3.4%

*computed as a % of the maximum reallocation possible. 100% would imply that after trade liberalisation all the production is carried out by the firms with the highest productivity $\overline{\nu}$

Table 5: Constraints variable and first stages

Financial Dev. IV shows the first stage of an instrumental variable regression for Constrained (Table 3) using as instrument a measure of financial development as in Guiso, Sapienza, Zingales (2004), Relationship Lending IV corresponds to a first-stage regression that uses as IVs for Constrained (Table 3) the length of the relationship with the bank, length of the relationship squared, and percentage of loans with main bank. The control variables included in the second stage are the age of the firm in years and age squared, the log of real total assets, year dummies, regional dummies (nort east, north west, center, south) and two digit level sector dummies. Other variables included in column 1 are the leverage ratio (debt over total assets), the liquidity ratio (cash and liquid assets over total assets) and the coverage ratio (profits before interest and taxes minus interest over profits). Standard errors in brackets. ***, **, * denote significance at a 1%, 5% and 10% level respectively.

	1 Justify	2 Financial Dev IV	3 Rel Lending IV
Financial Development	-0.0025***	-0.0025***	
	[0.00015]	[0.00013]	
Percentage loans with main bank	0.0008***		0.00081***
	[0.00009]		[0.000080]
Length of main bank's relationship (years)	-0.0030***		-0.0043***
	[0.00046]		[0.00040]
Length of main bank's relationship squared	0.00005***		0.000069***
	[0.000008]		[0.000007]
Age (years)	0.00040*	-0.00053***	-0.00032
	[0.00023]	[0.00019]	[0.00021]
Age squared	-0.000004*	0.000003**	0.000001
	[0.000002]	[0.000002]	[0.000002]
Log Real Total Assets	-0.014***	-0.0137***	-0.0127***
	[0.0017]	[0.0014]	[0.0014]
Leverage ratio	0.271***		
	[0.012]		
Liquidity ratio	-0.052***		
	[0.0067]		
Coverage ratio	-0.000037		
	[0.000031]		
Observations	28821	37917	37917
R-squared	0.07	0.03	0.02

Table 6: Entry decision

TFP is total factor productivity, measured as the residual of a translog specification that uses capital and employment and is estimated at a 2 digit Ateco sector level on 3 year windows. sdTFP corresponds to the standard deviation of the TFP measure calculated at a 2 digit sector-year level. sdTFP/logsales corresponds to sdTFP divided by the average log sales calculated at a 2 digit sector-year level. Midconstrained is a dummy for the middle third quantile of the predicted financing constrained firms using the relationship lending instrumental variables as in Table 2. Similarly Highconstrained is a dummy variable for the top third quantile of predicted financing constraints. Controls in columns 3 and 6 include the log of real total assets, age, age squared, year dummies, 2 digit sector dummies and regional dummies. Standard errors in brackets. ***, **. * denote significance at a 1%, 5% and 10% level respectively.

	1	2	3	4	5	6
		sdTFP			sdTFP/log sales	
TFP	0.0123***	-0.0051***	0.0071***	0.00105***	-0.001***	-0.001***
	[0.00097]	[0.0019]	[0.0015]	[0.00010]	[0.000]	[0.000]
Midconstrained x TFP		0.016***	0.0040**		0.003***	0.002***
		[0.0026]	[0.0019]		[0.000]	[0.000]
Highconstrained x TFP		0.029***	0.011***		0.004***	0.003***
		[0.0025]	[0.0019]		[0.000]	[0.000]
Controls	No	No	Yes	No	No	Yes
Observations	33455	33455	33455	33455	33455	33455
R-squared	0.00	0.01	0.44	0.003	0.009	0.031

Table 7: Financing constraints and export decision

Instrumental variables for Constrained are defined as in Table 1. The control variables included in the second stage are the age of the firm in years and age squared, the log of real total assets, year dummies, regional dummies (nort east, north west, center, south) and two digit level sector dummies. Standard errors in brackets. ***, **, * denote significance at a 1%, 5% and 10% level respectively.

	1	2	3	4	5	6	7	8	9
	Export Dummy			% Sales Exported			Number of Regions		
	OLS	IV	IV	OLS	IV	IV	OLS	IV	IV
		Financ. Dev	Rel Lend.		Financ. Dev	Rel Lend.		Financ. Dev	Rel Lend.
Log Real Total Assets	.086***	.081***	.083***	3.066***	3.057***	3.166***	.358***	.347***	.353***
	[.0022]	[.0029]	[.0027]	[.199]	[.241]	[.225]	[.0082]	[.010]	[.0095]
TFP	.048***	.038***	.0354***	2.755***	3.696***	3.220***	.071***	.074**	.053**
	[.0046]	[.0084]	[.0068]	[.420]	[.776]	[.628]	[.017]	[.029]	[.024]
Constrained	.0070	-.281*	-.288**	.707	12.230	10.743	-.062**	-.379	-.468
	[.0067]	[.155]	[.113]	[.637]	[13.975]	[1.038485]	[.024]	[.535]	[.400]
Age (years)	.0012***	.00098***	.00095***	-.0167	-.0065	-.010705	.0068***	.0067***	.006***
	[.00027]	[.00031]	[.00030]	[.024]	[.025]	[.024819]	[.0010]	[.0010]	[.0011]
Age squared	-.000005**	-.000003	-.000003	-.00021	-.00029	-.00026	-.00003***	-.00003***	-.00003***
	[.000002]	[.000003]	[.000003]	[.00019]	[.00021]	[.000207]	[.000009]	[.000009]	[.000009]
Observations	29173	29173	29173	15593	15593	15593	29334	29334	29334
R-squared	.17	.11	.11	.14	.12	.13	.18	.17	.17

Table 8: Becoming an exporter and liquidity

Export is a dummy variable that takes value one if the firm is exporting. Start Exportingt is a dumy variable that takes value one on the four years prior and up to the moment when the firmsl becomes an exporter. Columns 2-3 and 5-6 correspond to nested regressions in which all the independent variables are interacted with dummies associated with the firm being above or below median predicted financing constraints. Predicted financing constraints are calculated using the relationship lending variables as in table 1. TFP is total factor productivity, measured as the residual of a translog specification that uses capital and employment and is estimated at a 2 digit Ateco sector level on 3 year windows. All regressions include as control variables year dummies and two digit level sector dummies. Standard errors in brackets. ***, * , * denote significance at a 1%, 5% and 10% level respectively.

	1	2	3	4	5	6
		Nested Regression			Nested Regression	
	all	constrained	unconstr.	all	constrained	unconstr.
TFP x Productive				-0.008*	-0.039***	0.042***
				[0.004]	[0.005]	[0.005]
Start Export.xProductive				0.037**	0.060***	0.046
				[0.018]	[0.019]	[0.064]
Export	-0.040***	-0.062***	-0.015***	-0.041***	-0.067***	-0.017***
	[0.004]	[0.0051]	[0.005]	[0.004]	[0.006]	[0.005]
Start Exporting	-0.033***	-0.014	-0.068***	-0.058***	-0.053***	-0.118***
	[0.008]	[0.008]	[0.017]	[0.014]	[0.015]	[0.040]
Log real total assets	-0.084***	-0.060***	-0.063***	-0.083***	-0.057***	-0.073***
	[0.0014]	[0.0018]	[0.003]	[0.0016]	[0.002]	[0.0036]
Age (years)	-0.001***	-0.003***	0.002***	-0.001***	-0.003***	0.002***
	[0.0002]	[0.0002]	[0.0002]	[0.00020]	[0.0002]	[0.0002]
Age squared	0.000008***	0.00003***	-0.00002***	0.000008***	0.00002***	-0.00002***
	[0.000002]	[0.000002]	[0.000002]	[0.000002]	[0.000003]	[0.000002]
Observations	29080	29080		24711	24711	
R-squared	0.18	0.19		0.18	0.20	

Table 9: Predictive power of productivity on exports by level of predicted constraints

TFP is total factor productivity, measured as the residual of a translog specification that uses capital and employment and is estimated at a 2 digit Ateco sector level on 3 year windows. Highconstrained and Midconstrained correspond to firms on the top third and middle third of the predicted financing constraints variable respectively. Predicted financing constraints are calculated using the relationship lending variables as in table 1. All regressions include as control variables year dummies and two digit level sector dummies. Standard errors in brackets. ***, **, * denote significance at a 1%, 5% and 10% level respectively.

	(1)	(5)	(9)
	export	all	regions
Log real total assets	0.062***	2.443***	0.309***
	[0.0036]	[0.288]	[0.012]
TFP	0.110***	4.683***	0.111***
	[0.0094]	[0.971]	[0.032]
Midconstrained x TFP	-0.039***	0.526	0.059
	[0.012]	[1.179]	[0.041]
Highconstrained x TFP	-0.134***	-4.508***	-0.158***
	[0.012]	[1.124]	[0.041]
Age (years)	0.00086***	-0.020	0.0063***
	[0.00029]	[0.024]	[0.0010]
Age squared	-0.000004	-0.00020	-0.000030***
	[0.000003]	[0.00020]	[0.000009]
Observations	29334	15593	29334
R-squared	0.16	0.14	0.18