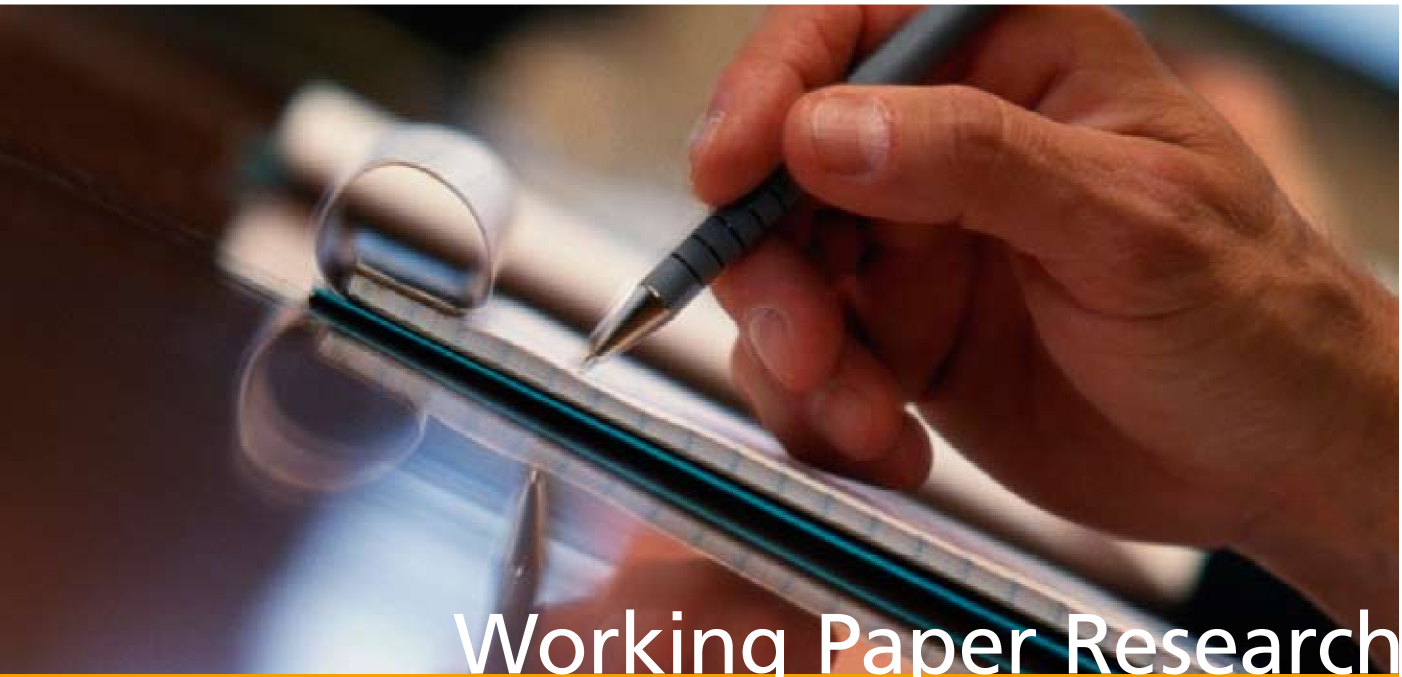
Exporters and credit constraints. A firm-level approach



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Abstract

By building a theoretical model and taking it to the data with two novel datasets, this paper analyses the interaction between credit constraints and exporting behaviour. Building a heterogeneous firms model of international trade with liquidity-constrained firms yields several predictions on the equilibrium relationships between productivity, credit constraints and exports that are then verified in the data. The main findings of the paper are that firms are more likely to be exporting if they enjoy higher productivity levels and lower credit constraints. Also, credit constraints are important in determining the extensive but not the intensive margin of trade in terms of destinations. This introduces a pecking order of trade. Finally, an exchange rate appreciation will cause existing exporters to reduce their exports, entry of credit-constrained potential exporters and exit of the least productive exporters.

Keywords: Credit constraints, heterogeneous firms, margins of export, export destinations, exchange rates and trade.

JEL-code : D92, F10, F36 and G28

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1 Introduction

In an era of increased globalisation, governments implement policies seeking to encourage local firms to become global and sell their goods on foreign markets. Governmental export agencies put in considerable effort and resources in setting up trade promotion trips, information packs, loans and subsidies, etc. Behind these policies lies the belief that it would be profitable for firms to export, but that they often lack the information and funds to go ahead, which is where their national authorities can help them. Despite the widespread use of these interventions, there is little empirical evidence on how important financial considerations are for the international expansion of firms.

Building a theoretical model and taking it to the data with two novel datasets, this paper considers the determinants of firm exporting behaviour. In particular, it seeks to analyse whether there is any interaction between financial and credit constraints on the one hand and exports on the other. The literature on firm-level trade has so far mostly concentrated on the interactions between trade and productivity. This paper considers another critical issue in understanding the exporting decisions of firms: the financial situation of the firm, and in particular the credit constraints it faces. Decisions by firms cannot solely rely on productivity considerations given that firms might be financially-constrained. In particular, these constraints will affect volumes and patterns of trade and the efficiency of the equilibrium outcome.

A heterogeneous firms model of international trade is constructed with liquidity-constrained firms. It yields several predictions on the equilibrium relationships between productivity, credit constraints and exports that are then verified in the data. The main contribution of this paper is to show that firms are more likely to be exporters if they are more productive *and* less credit-constrained. Regarding the patterns of trade, firms are more likely to start exporting to a new destination and to export to many destinations if they face fewer liquidity restrictions. Once they do start exporting to a given country, credit constraints do not affect the value and growth of their exports. There is therefore a strong relationship between the extensive margin of trade at the destination level and credit constraints, while the intensive margin is not affected. This is the second prediction of the model and holds in the data. Third, the data confirms the theoretical prediction of a pecking order of trade: firms exporting to the smallest and furthest away economies are more productive and less credit-constrained. Finally, the model allows one to consider an additional effect of the presence of credit-constrained potential exporters, by decomposing the consequences of a domestic currency appreciation on trade flows. The data reveals that three effects hold: existing exporters will export less, the least productive existing exporters stop exporting and the most productive constrained non-exporters start exporting.

The issue of financial constraints has very rarely been considered in the literature on international trade, and the main contribution of this paper is to present both theoretical and empirical findings on this matter. There is a large literature on exporting behaviour at the firm level and the characteristics of exporters, with a strong emphasis on the link between trade and productivity. On credit constraints, Chaney (2005b) provides a theoretical model of trade with heterogeneous firms, along the lines of Melitz (2003), and introduces an exogenous liquidity constraint to derive his results. However, he does not include any empirical test of his predictions. The model in this paper builds on his work but improves the way liquidity constraints are represented, thus yielding a richer framework. In Manova's (2006) paper, credit constraints interact with firm productivity, thus reinforcing the way those firms with higher productivity select into exporting. Despite the model being at the firm level, the focus of her paper is on the differences in countries' and sectors' access and need for external finance and how these shape export patterns. This model borrows her specification of financial constraints to which an exogenous component is added, but by considering a general rather than partial equilibrium, the analysis concentrates on the firm-level interactions between exports and credit constraints.

Empirically, the detail of the datasets used is particularly suitable for the question addressed. First, the trade and balance sheet data used covers the full sample of Belgian manufacturing, at the firm level, with detailed information on export participation, but also on the destinations and products exported. As previously shown in the literature, larger and more productive firms are more likely to be exporters (for example, Bernard and Jensen, 2004), and to export more products to more destinations. Credit constraints have not been included in most firm-level empirical studies of trade. Manova (2006) uses industry- and country-level data to test the predictions of her model. The literature on financial institutions and trade does likewise, showing that export volumes from financially-vulnerable sectors are higher in financially-developed countries (Beck, 2002 and 2003, Svaleryd and Vlachos, 2005 and Hur et al., 2006). Using firm-level analysis in this paper allows a better understanding of how firms vary within a given sector. The implications of the results would therefore allow policies to be better targeted. Second, the measure of credit constraint used is unique in its kind, as it is a yearly measure of the creditworthiness of firms, established by an institution external to the firm, a credit insurer - Coface International. Campa and Shaver (2002) present evidence of the relationship between export status and liquidity constraints for manufacturing firms in Spain in the 1990s. However, their data does not allow the actual export patterns at the firm level to be analysed in detail. Greenaway et al (2007) explore the impact of financial constraints on export participation by using balance sheet variables to measure these constraints. Also, a vast literature on the importance of liquidity constraints for firms, which will be briefly described when presenting the Coface score and its advantages, has developed several measures which mainly make it possible to categorise firms between financially-constrained or unconstrained. It examines the effects of credit constraints on different decisions, such as investment, but none of them applies these techniques to understanding exporting behaviour. The approach that follows uses an original and valid measure of credit constraint to gauge its importance on firm level exports.

This paper demonstrates the importance of credit constraints when considering export patterns at the level of the firm. It leads to a more general question of the role of liquidity constraints for firm dynamics and growth (Rossi-Hansberg and Wright, 2006) and for export growth within the firm, fruitful areas for future research.

The paper is organised as follows. Section 2 develops the model and its predictions. Section 3 presents the data, and demonstrates in particular why the Coface score is an appropriate measure of credit constraints. Section 4 contains the empirical analysis of the links between export patterns and credit constraints and Section 5 concludes.

2 The model

This section presents a model of trade with liquidity-constrained firms in a Melitz (2003)-type heterogeneous firms model of international trade. Only two models in the literature on heterogeneous firms and export decisions consider financing constraints, namely Chaney (2005b) and Manova (2006). This model extends the existing literature by incorporating external financing into Chaney's model. As a result, a firm has three sources of liquidity to finance the sunk costs of exporting. A firm's liquidity comprises internal financing and exogenous shocks as in Chaney (2005b) as well as external financing. This implies that the firm faces credit constraints due to imperfect financial contractibility, as in Manova's approach (2006). The purpose of writing a model featuring both internal and external constraints will allow us to properly specify the empirical approach using firm-level data and capture certain specificities of the data. In future work, an extension of the model into a dynamic setting would allow the analysis of the interactions between the different sources of financing and the possibility of their sequential use.

2.1 Set-up

The economy consists of two countries Home and Foreign (the latter is hereafter denoted with an asterisk *). The only factor of production is labour, and population is of size L. There are two sectors. One sector provides a single homogeneous good which is freely traded. This good is used as the numeraire, and its price is therefore equal to 1. Production in this sector is characterised by constant returns to scale with $q_0 = B \times l_0$, l_0 being the labour used to produce quantity q_0 of the good. By choice of scale, the unit labour requirement at home is $1/w$ $(B = w)$ and $1/w^*$ in foreign($B^* = w^*$). Therefore, as shall be assumed, if both countries produce the homogeneous good, wages will be fixed by this sector's production at w and w^*respectively. The second sector produces a continuum of differentiated goods. Each firm operating in this sector supplies one of these goods and is a monopolist for its variety.

2.2 Demand

Consumers are endowed with one unit of labour and their preferences over the differentiated good display a constant elasticity of substitution (CES). Given their love of variety, they will consume all available varieties. The utility function of the representative consumer can be represented by U:

$$U \equiv q_o^{1-\mu} \left(\int\limits_{\omega \in \Omega} q(\omega)^{\frac{\sigma-1}{\sigma}} d\omega \right)^{\frac{\sigma}{\sigma-1}\mu} \tag{1}$$

where the utility level is determined by the consumption of q_0 units of the homogeneous good and $q(\omega)$ units of each variety ω of the differentiated good. The set Ω includes all varieties ω and is determined in equilibrium. The constant elasticity of substitution between any two varieties of the differentiated good is denoted by $\sigma > 1$.

If all varieties in Ω are available domestically at price $p(\omega)$ the ideal price index will be:

$$P = \left(\int\limits_{\omega \in \Omega} p(\omega)^{1-\sigma} d\omega \right)^{\frac{1}{1-\sigma}} \tag{2}$$

This implies that the representative consumer has an isoelastic demand function for each differentiated variety $q(\omega)$:

$$q(\omega) = \mu w L \left(\frac{p(\omega)^{-\sigma}}{P^{1-\sigma}} \right) \tag{3}$$

This demand function, given the domestic price $p(\omega)$, implies that the representative consumer spends $r(\omega)$ on each variety ω, where $\mu w L$ is the total amount spent on differentiated goods:

$$r(\omega) = \mu w L \left(\frac{p(\omega)}{P} \right)^{1-\sigma} \tag{4}$$

2.3 Production

Production in the differentiated goods sector is characterised by a constant marginal cost. Both countries enjoy the same technology and the marginal product of labour is constant. As in Chaney (2005a), it is assumed that there is a fixed number of potential entrants proportional to the size of the country, such that the mass of firms in each country in that sector is also proportional to L or L^*. There are fixed costs for a firm to start producing: each firm has to pay a fixed entry cost C_d in terms of domestic labour, at a price wC_d in terms of the numeraire. This introduces increasing returns to scale in the production process.

Each firm chooses to produce a different variety ω. It draws a random unit labour productivity $x \geq 0$ which determines its production cost. As in Melitz (2003), higher productivity is modelled as producing a given variety at a lower marginal cost. There are also two types of trade barriers if a firm wishes to serve Foreign. First, the firm needs to pay a fixed cost of exporting C_f, paid exclusively in terms of foreign labour, which is w^*C_f in terms of the numeraire. The crucial assumption of this cost being borne in terms of foreign labour is justified, as firms need, for example, to cover the cost of travelling to the country for prospection, buying local information, carrying out marketing and competition studies, tailoring goods to local demand and establishing a distribution network. A second part of fixed costs of exporting paid at home in terms of domestic labour would lower the number of exporters and amount of total exports but would not change the qualitative results of the model. The same assumption is made in Chaney (2005b).

Serving the foreign market also involves a variable "iceberg" transport cost τ. Shipping one unit of any variety of the differentiated good implies only fraction $1/\tau$ arrives in Foreign because the rest melts on the way.

These different assumptions mean that the cost of producing quantity q_d for the home market is $c_d(q_d)$:

$$c_d(q_d) = q_d \frac{w}{x} + wC_d \tag{5}$$

and cost of producing q_f units for the foreign market is $c_f(q_f)$, given the firm is already producing for domestic consumers:

$$c_f(q_f) = q_f \frac{\tau w}{x} + w^* C_f \tag{6}$$

Given firms are monopolists for the variety they produce, they set the price. Given the isoelastic demand functions, the optimal price is a constant mark-up over unit cost, including transport cost. This implies:

$$p_d(x) = \frac{\sigma}{\sigma - 1} \times \frac{w}{x} \tag{7}$$

at Home, and:

$$p_f(x) = \frac{\sigma}{\sigma - 1} \times \frac{\tau w}{x} \tag{8}$$

in Foreign.

These pricing choices imply that any given firm having drawn productivity level x, could make a profit of $\pi_d(x)$ in the domestic market, and $\pi_f(x)$ abroad:

$$\pi_d(x) = \frac{r_d(x)}{\sigma} - wC_d = \frac{\mu}{\sigma} wL \left(\frac{\sigma}{\sigma - 1} \frac{w}{xP} \right)^{1-\sigma} - wC_d \tag{9}$$

$$\pi_f(x) = \frac{r_f(x)}{\sigma} - w^*C_f = \frac{\mu}{\sigma} w^* L^* \left(\frac{\sigma}{\sigma - 1} \frac{\tau w}{xP^*} \right)^{1-\sigma} - w^* C_f \tag{10}$$

In order to survive, a firm will need to produce domestically with a profit, whereas in order to export, it will need to profitably produce for foreign consumers. Given equations (9) and (10), this leads me, as in Melitz (2003) and Chaney (2005a and b) to define two productivity thresholds, $\overline{x}_d$ and $\overline{x}_f$, at which firms respectively choose to start producing and exporting, when they face no liquidity constraint:

$$\pi_d(\overline{x}_d) = 0 \text{ and } \pi_f(\overline{x}_f) = 0 \tag{11}$$

The monopolistic competition setting and the heterogeneity of firms in terms of productivity implies a partition of firms between producers/non-producers and exporters/non-exporters if trade costs are sufficiently high. From the profit functions, it is clear that more productive firms will be able to charge lower prices, therefore ensuring themselves larger market shares and benefiting from larger profits, both in the domestic and export markets. On the domestic market, this means that the least productive firms do not survive, although the imperfect nature of competition implies that some low-productivity firms are protected from competition if σ is finite and can therefore survive. Similarly, on foreign markets, a partition is made as only the most productive firms export. Given that $(\overline{x}_f/\overline{x}_d)^{\sigma-1} = (\tau^{\sigma-1}C_f/C_d)\times(L/L^*)\times(P/P^*)^{\sigma-1}$, if trade barriers are assumed high enough, $\overline{x}_f > \overline{x}_d$ will always hold. This implies that firms that are productive enough to export are also producing domestically.

The model so far is identical to Chaney (2005b), and almost identical to Melitz (2003) but for the presence of a numeraire sector, the firms' entry process and potential asymmetry between countries. Liquidity constraints are now introduced.

2.4 Liquidity constraints

In the setting above, exporting involves fixed costs. These must mostly be paid before any profits are made abroad. If financial markets are imperfect, this leads to ex-ante under-investment in exporting activities. A different nature of contracting and informational environment in Foreign implies that this is more the case than for domestic entry costs. Foreign activities are less verifiable and are considered more risky, as they involve, for example, the use of a foreign currency. The weak contracting environment in some foreign countries means it is harder to recover unpaid dues abroad, and therefore firms are unable to pledge as much collateral for exports. These different elements mean that potential investors or lenders may not be willing to help would-be exporters cover the fixed cost of starting to export.

Combining the assumptions made in Chaney (2005b) and Manova (2006) allows the construction of a richer model, which will be better suited to analyse the data thereafter. Modelling the investor's decision in extending credit to firms more explicitly than in Chaney's set-up allows one to capture the interaction that exists between a firm's performance and its liquidity. But including an exogenous component to liquidity, as in Chaney (2005), allows for the presence of firms with no liquidity constraints but low productivity, as in the data. Also, by making some simplifying assumptions on price indices, as in Chaney, the model can be solved in a general equilibrium and thereafter can analyse the effects of exchange rate appreciations. The resulting model offers interesting predictions that are then taken to the data.

It is assumed, for simplicity, that there is no liquidity or credit constraint for firms to finance their domestic production. In a first step, as in Manova (2006), firms can finance the variable cost of exporting internally. The fixed cost of exporting is assumed to be financed in three different ways. First, a firm can use the profits generated from domestic sales $\pi_d(x)$. Second, each firm is endowed with an exogenous random liquidity shock A, denominated in units of domestic labour. Its value is hence wA. A and x (the productivity parameter) are drawn from a joint distribution with cumulative distribution function $F(A, x)$ over $\mathbb{R}^+ \times \mathbb{R}^+$, and $F_x(x) \equiv \lim_{A\to\infty} F(A, x)$ over $\mathbb{R}^+$. It is also assumed that the group of entrepreneurs, and hence the mass of firms entering the lottery, is proportional to L, the size of the country.

Third, a firm can decide to borrow an amount E on financial markets. In order to do so, it must pledge tangible assets as collateral, and it is assumed that these will be proportional to the fixed cost paid to enter the domestic market (e.g. cost of building the factory). The proportionality t_s is inherent to the nature of the industry with s denoting the sector, as in Manova (2006) and Braun (2003): $t_s wC_d$ will be pledgeable as collateral on financial markets. The probability of a firm defaulting on its loan is $1 - \lambda$, which reflects the level of financial contractibility, exogenously determined by the strength of financial institutions in the home country (in the empirical section, Belgium). The contracting timing is as follows. At the start of each period, potential investors receive a take-it-or-leave-it offer contract from each firm, detailing the amount to be borrowed, the repayment G and the collateral. Revenues are then realised and, at the end of the period, the creditor claims the collateral $t_s wC_d$ if the firm defaults, or receives payment $G(x)$ if the contract is enforced.

Given these three possibilities for financing the fixed cost of exporting, the liquidity constraint can be expressed as: $wA + \pi_d(x) + E \geq w^*C_f$. A higher domestic profit therefore relaxes the firm's credit constraint. The firm needs to borrow kw^*C_f to cover the fixed cost of exporting, by defining the share $(1-k)$ of this cost that can be covered internally by the firm such that $(1-k)w^*C_f = wA + \pi_d(x)$. As domestic profit increases, k decreases and the firm is less credit-constrained.

Below, the expression for profits on the foreign market reflects the fact that the firm finances a fraction $(1-k)$ of the fixed costs and all of its variable costs internally. As for the share k that is financed externally, the exporter pays with probability λ the investor $G(x)$ when the financial contract is enforced and with probability $1-\lambda$ replaces the collateral claimed by the creditor. Exporters from Home choose their price and output levels for foreign by maximising profits on the foreign market:

$$\pi_f(x) = p_f(x)\,q_f(x) - \frac{q_f(x)\tau w}{x} - (1-k)\,w^*C_f - \lambda G(x) - (1-\lambda)\,t_s w C_d \qquad (12)$$

subject to

$$q_f(x) = \mu w^* L^* \frac{p_f(x)^{-\sigma}}{P^{*1-\sigma}}$$

$$NR(x) = p_f(x)\,q_f(x) - \frac{q_f(x)\tau w}{x} - (1-k)\,w^*C_f \geq G(x)$$

$$B(x) = \lambda G(x) + (1-\lambda)\,t_s w C_d - k w^* C_f \geq 0$$

There are three constraints to this maximisation problem. The first condition arises even without imperfect financial markets, as it represents the demand condition. The second condition reflects the maximum net revenues $NR(x)$ the firm can offer to the creditor: its revenue on the foreign market, minus the variable cost and share $(1-k)$ of fixed cost, both financed internally. The third condition expresses the net return to the investor $B(x)$ being positive. This is equal to their expected return, given the probability of default, minus the amount they have lent to the exporter to finance a share k of the fixed cost. The investor will only finance the firm if he expects to at least break even. The amount borrowed by the firm from the external investor is $kw^*C_f = [w^*C_f - wA - \pi_d(x)]$[1].

As credit markets are competitive, all investors break even and have zero expected profits. Firms choose $G(x)$ so as to bring the investor to his participation constraint. $B(x) = 0$ in equilibrium. This implies that the firm's maximisation problem is identical to the case without credit constraints, except that $G(x)$ cannot be greater than net revenues. Hence, as in Melitz (2003):

$$p_f(x) = \frac{\sigma}{\sigma-1} \times \frac{\tau w}{x}\ ,\ q_f(x) = \left(\frac{\sigma}{\sigma-1}\frac{\tau w}{x}\right)^{-\sigma} \frac{\mu w^* L^*}{P^{*1-\sigma}}\ , \qquad (13a)$$

$$\pi_f(x) = \frac{r_f(x)}{\sigma} - w^*C_f = \frac{\mu}{\sigma} w^* L^* \left(\frac{\sigma}{\sigma-1}\frac{\tau w}{xP^*}\right)^{1-\sigma} - w^*C_f\ , \qquad (13b)$$

$$r_f(x) = \mu w^* L^* \left(\frac{\sigma}{\sigma-1}\frac{\tau w}{xP^*}\right)^{1-\sigma} \qquad (13c)$$

If there are no credit constraints, the threshold $\overline{x}_f$ is therefore defined by

$$\pi_f(\overline{x}_f) = 0 \text{ or } r_f(\overline{x}_f) = \sigma w^* C_f$$

$$\overline{x}_f = \left(\frac{\sigma C_f}{\mu L^*}\right)^{\frac{1}{\sigma-1}} \frac{\sigma}{\sigma-1}\frac{\tau w}{P^*} \qquad (14)$$

[1] For simplicity, as in Manova (2006), I normalise the outside option of the investor to 0, rather than to the world-market net interest rate r. This does not change the qualitative predictions of the model.

Yet, taking into account the presence of imperfect financial markets and hence credit constraints, the second constraint of the profit maximisation problem of equation (12) is considered: $NR(x, p_f(\cdot), q_f(\cdot), B(x) = 0) = G(\overline{x}(A))$. This yields the following revenue function:

$$r_f(\overline{x}(A)) = \sigma\left[\frac{1}{\lambda}w^*C_f - \frac{(1-\lambda)}{\lambda}(t_s-1)wC_d - \frac{(1-\lambda)}{\lambda}wA - \frac{(1-\lambda)}{\lambda}\frac{\mu}{\sigma}wL\left(\frac{\sigma}{\sigma-1}\frac{w}{\overline{x}(A)P}\right)^{1-\sigma}\right] \tag{15}$$

Therefore, if $\lambda = 1$, this is equivalent to the original Melitz (2003) result of equations (13) and $\overline{x}(A) = \overline{x}_f$. If not, the productivity threshold for starting to export is defined by:

$$\overline{x}(A) = w\frac{\sigma}{\sigma-1}\left(\frac{\sigma}{\mu}\right)^{\frac{1}{\sigma-1}}\left[\frac{1}{\lambda}w^*C_f - \frac{(1-\lambda)}{\lambda}(t_s-1)wC_d - \frac{(1-\lambda)}{\lambda}wA\right]^{\frac{1}{\sigma-1}} \times \left[w^*L^*\left(\frac{\tau}{P^*}\right)^{1-\sigma} + \frac{(1-\lambda)}{\lambda}wL\left(\frac{1}{P}\right)^{1-\sigma}\right]^{\frac{1}{1-\sigma}}$$

Firms with productivity below $\overline{x}(A)$ will not be able to export due to credit constraints, despite some of them being sufficiently productive to do so profitably.

2.5 Open-economy equilibrium

In order to consider firm entry and exit and the effect of exchange rate variations, this subsection computes the open-economy equilibrium.

It is assumed for simplicity, as in Chaney (2005b), that the price index only depends on local firms' prices and that foreign firms do not face any liquidity constraints. Prices set by foreign firms for the varieties they sell at home only have a small impact on the general price index. In a relatively closed economy, it is a reasonable approximation, which allows for the model to be solved. The price index of equation (2) can be approximated by:

$$P \approx \left(\int_{x\geq\overline{x}_d} p_d(x)^{1-\sigma} L dF_x(x)\right)^{\frac{1}{1-\sigma}} \tag{17}$$

For convenience, function $h(.)$ is defined as:

$$h(\cdot): \overline{x}^{\sigma-1} = \left(\frac{\sigma}{\mu}\int_{x\geq\overline{x}} x^{\sigma-1} dF_x(x)\right) \times C \Longleftrightarrow \overline{x} = h(C) \tag{18}$$

with $h' > 0$

This allows one to rewrite the productivity thresholds of equations (11), (14) and (16) [2]:

$$\overline{x}_d = h(C_d) \tag{19}$$

$$\overline{x}_f = \left(\frac{C_f}{C_d^*}\right)^{\frac{1}{\sigma-1}} \tau\frac{w}{w^*}h(C_d^*) \tag{20}$$

which are equivalent to the results of Chaney (2005b), and

[2] Note that these thresholds do not depend on market sizes. This is due to the assumption that prices are determined by domestic producers only, whose number is proportional to the size of the market. Larger markets will have more varieties, and therefore profits will not be higher.

$$\overline{x}(A) = \left[\frac{(1-\lambda)(1-t_s) C_d + \frac{w^*}{w} C_f - (1-\lambda) A}{\lambda \tau^{1-\sigma} \left(\frac{w^*}{w}\right)^{\sigma} \left(h\left(C_d^*\right)\right)^{1-\sigma} C_d^* + (1-\lambda)\left(h\left(C_d\right)\right)^{1-\sigma} C_d} \right]^{\frac{1}{\sigma-1}} \tag{21}$$

All firms with productivity above $\overline{x}_d$ will be producing for domestic consumers. Firms with a productivity above $\max\{\overline{x}_f, \overline{x}(A)\}$ will be able to export because they are both productive enough and have sufficient liquidity to cover the fixed costs.

Equation (21) reflects the way firms cover fixed costs of exporting and how productivity levels will affect their decision to export. First, note that if financial contracts were perfectly enforced and $\lambda = 1$, the two thresholds $\overline{x}_f$ and $\overline{x}(A)$ are equal. If this is not the case, looking at A, the amount of exogenous liquidity matters. Firms with a small amount of exogenous liquidity will need to compensate with a higher productivity level to be able to have both a larger profit on the domestic market and a better access to external finance to pay upfront the fixed cost of exporting. Firms with higher productivity can obtain more outside finance because their net revenues and the repayments they offer their investors will be greater. Naturally, a higher fixed cost of exporting C_f also increases the threshold, all other things being equal. Firms in sectors in which tangible assets are more easily collateralisable (higher t_s) will need a lower level of productivity to obtain sufficient external finance and domestic profits to become exporters.

The impact of domestic fixed-entry cost is ambiguous. On the one hand, a higher C_d implies lower profits on the domestic market, thus reducing available liquidity and increasing the threshold. On the other, it implies higher tangible assets, and also makes it more difficult for firms to start producing at home, hence reducing competition, increasing market shares of those that do survive and consequently their profits. The total effect depends on the distribution of firm productivity. Two other elements will be affecting the profitability of the foreign markets, and hence the productivity threshold. This is also true for the threshold with no liquidity constraints. First, the greater the iceberg cost τ, the lower the profits in Foreign. A lower C_d^* means that more foreign firms will be entering their own market, hence reducing the market shares of home exporters and their profits. The reduction in the profitability of foreign markets has an additional effect in the presence of financial frictions, as it will reduce the repayments they can offer to investors. Finally, the relative wage w^*/w affects the productivity threshold through three channels. When it decreases, so does $\frac{w^*}{w} C_f$: the fixed cost of entry into the foreign market being paid in foreign wages will imply less domestic liquidity needed to be an exporter. Second, as in the absence of liquidity constraints, a decrease in Foreign's wage implies a smaller market abroad. A higher wage at home increases production costs. Together, these imply lower profits in Foreign and therefore a higher productivity threshold. The third effect of a lower relative wage occurs in the presence of liquidity constraints, where $\lambda < 1$. Lower net revenues imply a higher liquidity constraint, and hence an even higher productivity threshold to compensate.

These various elements determine the productivity threshold for exporting that holds when firms are liquidity-constrained, and hence the number of exporters and their entry and exit into foreign markets. Some firms, despite being productive enough to profitably export will be liquidity-constrained and will therefore not export if $\overline{x}(A) > \overline{x}_f$. Proposition 1 states the condition under which there will be a set of such firms[3], and for the remainder of this paper, this assumption holds.

[3] This proposition is close to Chaney (2005)'s Proposition 1.

Proposition 1 *If* $\left[\frac{C_d^*}{C_f}\frac{(1-\lambda)(1-t_s)C_d+\frac{w^*}{w}C_f}{\lambda\tau^{1-\sigma}\left(\frac{w^*}{w}\right)^{\sigma}C_d^*+(1-\lambda)\left(\frac{h(C_d)}{h\left(C_d^*\right)}\right)^{1-\sigma}C_d}\right]^{\frac{1}{\sigma-1}} > \frac{\tau w}{w^*}$, *there is a non-empty set of liquidity-constrained firms that are prevented from profitably exporting because they have insufficient liquidity, both exogenously and on the external financial market.*

Proof. See appendix A. ■

Firms that have a very low productivity, below $\overline{x}_d$, will not even produce domestically. Some firms will be productive enough to produce domestically, but for which it will not be profitable to export. Their productivity will be below $\overline{x}_f$. Firms whose productivity is between $\overline{x}_f$ and $\overline{x}(A)$ either have a too low exogenous liquidity shock A, or are not productive enough to raise external finance, or a combination of both. Firms with productivity above $\overline{x}(A)$ have a sufficiently high A combined with a high enough productivity to both pay the fixed cost of exporting and profitably export. Some even more productive firms would be able to export whatever the A they have, as they would be able to cover the whole fixed cost of exporting with domestic profits and external finance. Finally, the most productive firms need neither an exogenous liquidity shock A, nor access to external finance, and exclusively finance their fixed cost of exporting through domestic profits.

2.6 Destinations

In this section, the model is extended to the case in which there are more than two countries, and each firm in Home can decide to export to more than one destination.

In that case, it needs to pay the fixed cost of exporting to each of the destinations it serves. Without credit constraints, all destinations to which a firm could profitably export are served. However, with credit market imperfections, a firm which has limited available liquidity will only be able to pay the fixed cost of exporting to a certain number of countries. On the external financing side, if a firm decides to export to n destinations, then the available collateral for each destination will be $\frac{t_s w C_d}{n}$. The exogenous liquidity and domestic profits available for covering the fixed cost of serving each destination will be also divided by n.

In partial equilibrium analysis, in which the price index is taken as given and not affected by the productivity thresholds that determine entry and exit of firms, this yields the following productivity threshold:

$$\overline{x_n}(A) = w\frac{\sigma}{\sigma-1}\left(\frac{\sigma}{\mu}\right)^{\frac{1}{\sigma-1}}\left[\frac{1}{\lambda}w^*C_f - \frac{(1-\lambda)}{\lambda}\left(\frac{t_s}{n}-1\right)wC_d - \frac{(1-\lambda)}{\lambda}\frac{wA}{n}\right]^{\frac{1}{\sigma-1}} \times \left[w^*L^*\left(\frac{\tau}{P^*}\right)^{1-\sigma} + \frac{(1-\lambda)}{\lambda}w\frac{L}{n}\left(\frac{1}{P}\right)^{1-\sigma}\right]^{\frac{1}{1-\sigma}}$$

In general equilibrium, domestic general price indices are determined in each country by domestic producers, as approximated in equation (17). Assuming C_f is identical for all n countries served, the productivity threshold for exporting to one of the foreign countries with wage w^* and cost C_f, given you are exporting to $n-1$ other countries is:

$$\overline{x_n}(A) = \left[\frac{\left(1-\frac{t_s}{n}\right)(1-\lambda)C_d + \frac{w^*}{w}C_f - (1-\lambda)\frac{A}{n}}{\lambda\tau^{1-\sigma}\left(\frac{w^*}{w}\right)^{\sigma}\left(h\left(C_d^*\right)\right)^{1-\sigma}C_d^* + (1-\lambda)\left(h\left(C_d\right)\right)^{1-\sigma}\frac{C_d}{n}}\right]^{\frac{1}{\sigma-1}} \tag{23}$$

The productivity threshold for firms to export will be increasing in the number of destinations they decide to serve when financial markets are imperfect and $\lambda < 1$. The exogenous liquidity shock and the domestic tangible fixed assets used as collateral (and hence the available external finance) will need to be shared to pay for the fixed costs of the n destinations served. This will increase the productivity level needed to ensure higher domestic profits and more external finance will compensate for the additional need for liquidity.

Proposition 2 *If the condition in Proposition 1 holds, there is a non-empty set of liquidity-constrained firms that are prevented from profitably exporting to n destinations because they have insufficient liquidity, both exogenously and on the external financial market. As a result, more productive and less credit-constrained firms will export to more destinations.*

Proof. Given the condition in Proposition 1 holds, $\overline{x}(A) > \overline{x}_f$. In the absence of financial constraints, with C_f common to all markets, $\overline{x}_f$ does not vary across destinations, nor with the number of destinations served. Hence any firm productive enough to profitably export to one country will also be able to export to n destinations. This is not the case with credit constraints. As $\overline{x_1}(A) = \overline{x}(A)$ and $\frac{\partial \overline{x_n}(A)}{\partial n} > 0$, the thresholds are such that $\overline{x_n}(A) > \overline{x_{n-1}}(A) > \overline{x_{n-2}}(A) > ... > \overline{x_2}(A) > \overline{x_1}(A) > \overline{x}_f$, hence the result. ■

Without considering entry and exit of firms, whatever the number of destinations being served, the productivity threshold for exporting to larger markets is lower, as can be seen from equation (22). Net revenues for firms exporting to such markets are also larger, which means they will be less credit-constrained, all other things equal. The effect of the size of the market needs to be balanced with that of iceberg trade costs: a very large market will be less profitable if it is located far from the Home economy and that trade costs are therefore higher. From equation (22) it is straightforward to show that:

$$\frac{\partial \overline{x_n}(A)}{\partial \left(\frac{L^*}{\tau^{\sigma-1}}\right)} < 0 \tag{24}$$

One can therefore order all potential destination markets according to $\frac{L^*}{\tau^{\sigma-1}}$, their size weighted by the iceberg cost that applies to them. This ordering will also correspond to the profits derived from exporting to those countries: the higher $\frac{L^*}{\tau^{\sigma-1}}$, the higher the profit as given by equation (13). This introduces a pecking order of trade:

Proposition 3 *Firms will add export destinations in decreasing order of trade cost weighted market size, $\frac{L^*}{\tau^{\sigma-1}}$. More productive firms will export to more destinations, but also to relatively smaller markets.*

Proof. See appendix B. ■

This result is similar to that of Manova (2006), except for the important trade cost weighting dimension. It does not carry over directly to general equilibrium because of the assumption made on prices. In the open equilibrium economy, thresholds will depend on trade costs, but not on market size.

2.7 Exchange rate appreciation effect

An appreciation of the domestic currency with respect to the foreign currency means domestic exporters are less competitive in the foreign market. As argued by Chaney (2005b), it also relaxes the liquidity constraint faced by potential exporters given the fixed cost of exporting is paid in foreign currency. The value of their domestic liquidity in terms of foreign currency, be it domestic profits, exogenous cash flow or credit, has increased. Existing exporters export less, but some new firms enter the market. These entrants are liquidity-constrained firms who are productive enough to export. The liquidity effect dominated the competitiveness effect, but the appreciation relaxes the constraint and allows them to start exporting. This means that the extensive and intensive margin of exports to a given destination are affected differently by an appreciation of the exchange rate. Exchange rate variations can be modelled as a shock on relative wages. As used by Atkeson and Burstein (2005), an increase in the productivity in the homogeneous sector at home leads to an increase in the domestic wages, and hence in the value of domestic assets (wA and $\pi_d(x)$). In Foreign, $p_f(x)/P^*$ increases, reflecting the loss of competitiveness of domestic exporters, as in the case of an appreciation of the domestic currency.

Proposition 4 *An appreciation of the exchange rate between the domestic and the foreign currencies has three effects:*
(1) Existing exporters become less competitive and reduce their exports
(2) The least productive existing exporters stop exporting
(3) The most productive constrained non-exporters start exporting

Proof. (1) The revenue, or total value of exports, of a firm that is already an exporter in Foreign and with productivity x is given by $r_f(x)$. In the presence of liquidity constraints, plugging the productivity thresholds of equations (19), (20) and (21) with the price index in equation (17) into the revenue equation (4), revenue is then equal to

$$r_f(x) = \sigma w^* C_d^* \left(\frac{w^*}{\tau w} \frac{x}{\overline{x}_d^*} \right)^{\sigma - 1} \tag{25}$$

As domestic exporters face higher-priced inputs at home, they need to charge higher prices in Foreign to maintain mark-ups, thus losing export market shares and reducing exports, as can be seen from differentiating equation (25):

$$\frac{\partial r_f(x)}{\partial w} = -r_f(x) \frac{(\sigma - 1)}{w} < 0$$

(2) As a consequence of (1), losing competitiveness also reduces the profits made in Foreign. Given equation (13b) and the proof of (1),

$$\frac{\partial \pi_f(x)}{\partial w} = -r_f(x) \frac{(\sigma - 1)}{\sigma w} < 0$$

For the least productive firms, as the fixed cost of entering foreign $w^* C_f$ is unchanged, exporting is no longer profitable. The productivity threshold $\overline{x}_f$ given in equation (20) increases, as $\frac{\partial \overline{x}_f}{\partial w} = \frac{\overline{x}_f}{w} > 0$

(3) An appreciation causes the exogenous liquidity and domestic profits to increase. This facilitates the obtention of credit for a given productivity level and therefore relaxes the liquidity constraint. Although profits in Foreign are reduced, the first effect dominates when the condition in Proposition 4.1 holds. As $\frac{\partial \overline{x}(A)}{\partial \frac{w^*}{w}} > 0$ (shown in appendix C), $\overline{x}(A)$ decreases and constrained exporters who were prevented from entering the foreign market are now able to do so. ■

This means that an appreciation of the domestic currency, modelled as an increase in domestic wages, will lead to entry and exit of exporters. Existing exporters with low productivity and no liquidity constraint lose competitiveness in the foreign market and exit. Given they earn less profits, they are not able to cover the fixed cost, and this raises the productivity threshold for remaining on the export market. On the other hand, high productivity firms that were kept out of foreign markets by their liquidity constraint will now be able to enter. The appreciation implies that profits at home and the value of their tangible assets are increased, thus reducing their liquidity constraint. These effects are similar to those described in Chaney (2005b), although the third effect is slightly modified by the financial market which is modelled here. In both cases, the presence of incomplete financial markets and liquidity constraints implies that exports no longer depend only on the competitiveness of exporters. The cost of exporting relative to domestic assets is also important and it varies with exchange rates.

We now turn to the empirical analysis in order to verify whether the model's predictions are confirmed in the data.

3 Data

3.1 The Belgian Balance Sheet and Trade Transaction Data

This dataset was presented in detail in Muûls and Pisu (2007). It merges firm-level balance sheet and trade data for Belgium. The balance sheet part of the BBSTTD is used to extract firm-level annual characteristics, including employment, value added, financial situation, sector of activity and to compute total factor productivity. Only the export data side of the trade data is used in this paper, and includes the destinations, products and value information[4].

Manufacturing firms only are selected as belonging to sectors 15 to 36 of the NACE-BEL classification. Firms from sector 232 (refined petroleum products) are excluded as their total factor productivity (TFP) measures are strong outliers. Only firms with more than one full-time equivalent employee are kept in the dataset. The data is then merged into the Coface database, described in the following subsection, and only firms for which a Coface score is given for each year a balance sheet was available is kept in the dataset. All observations are kept in the dataset[5], which is described in Table 5.

3.2 Measuring Credit Constraints: the Coface score

As a measure of credit constraints, the Coface Services Belgium Global Score for around 9,000 Belgian manufacturing firms between 1999 and 2005 is used[6]. This section describes the activities of Coface, the construction of the score, justification for using it as a measure for credit constraints, and an external validation through its comparison with other techniques found in the literature on credit constraints.

3.2.1 The Coface score

Coface International Established in France in 1945 as a credit insurance company, Coface has grown in the past 15 years to become a world provider of services to facilitate business-to-business trade. Besides offering receivables finance and managing and collecting commercial receivables for its clients, it also provides credit information and insurance services.

Through a worldwide network of credit information entities, it has constituted an international buyer's risk database on 44 million companies. Data from public and private sources are added to Coface's internal data in order to manage each company's rating and Coface's risk exposure on a continuous basis.

Based on this database, it can offer credit insurance policies and therefore allows its clients to tackle customer insolvency, bad debts, overdue accounts, commercial risks and political risks when trading on credit terms. With the same database, it also provides its clients with credit information on other firms.

Within the Basel II framework for regulatory capital requirements, banks may choose to compute their regulatory capital requirement through the internal ratings-based approach, hence providing a measure of the probability of default for each borrowing company. There

[4]Given the difference of threshold for data to be available when a firm exports within the EU and outside the EU (see Muûls and Pisu, 2007), we do not consider as exporters firms that export only outside the EU and whose annual total of imports and exports is lower than 250,000 Euros.

[5]Note that in the BBSTTD, observations with a negative value-added or with less than one employee are dropped.

[6]There are 62,569 year-firm observations. In 1999, 9,268 firms, and in 2005, reflecting the decline of manufacturing reported in Muûls and Pisu (2007), only 8,411 firms.

has therefore been an incentive for credit insurance firms such as Coface to also offer their services to banks who wish to outsource this measurement.

Why is it a good measure of credit constraints?

The Coface score, despite being constructed as a bankruptcy risk measure, is highly correlated with how credit-constrained a firm is. It will reflect the same type of information that a bank would use to decide whether it lends to a firm. In some sense, by covering the risk for its clients of trading with firms that have a good score, Coface also provides these firms with a form of extra liquidity through a short-term debt from their suppliers: it gives a firm the opportunity to pay for the goods or services provided by Coface's client at a later date. This is reflected in the term "credit insurance".

Although it is clearly endogenous to the firm's performance and characteristics, it is not directly affected by its exporting behaviour, given that this is not public information in Belgium and that it does not enter the Coface's score determination model. Being determined independently by a private firm, the Coface score is therefore a very useful measure of credit constraint for the purposes of this paper. It is unusual for such data to be available and has a great advantage on measures of credit constraints used in the literature so far: it is firm-specific, varies through time on a yearly basis and allows for a measure of the degree of credit constraint rather than classifying firms between the two constrained or unconstrained categories. Although the score is updated by Coface on a continuous basis, the data provided by the company for this paper only reports the score of each firm on 31 December.

The score is endogenous to some of the other firm's characteristics, as illustrated in Figure (1). In the empirical section, the equilibrium relationships from the model will be estimated, and no causality relation established. The model presented in the previous section predicts that credit constraints are endogenous. The score contains information about the credit constraints a firm faces but also about its quality, performance and productivity. Two firms with equally valuable projects, and identical profitability and productivity can be very different in terms of financial health, board structure, and other elements that will determine their score and their access to credit. The empirical analysis will therefore seek to control for a number of variables that could potentially influence both the Coface score and the exporting activity under study, such as size and productivity of firms.

The Coface score is a well-suited direct measure of creditworthiness used by other firms and by banks when extending loans, and will be used in the empirical analysis to measure how credit-constrained firms are.

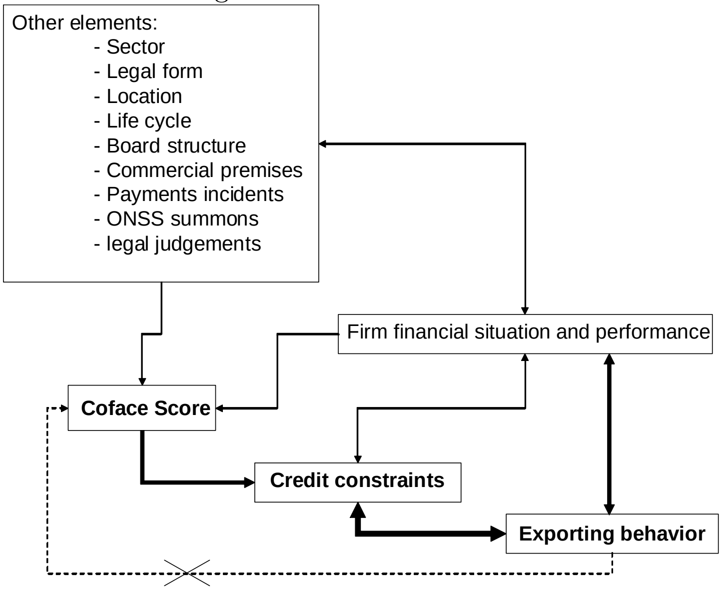
Construction of the score

As presented in Mitchell and Van Roy, 2007, there is a large academic literature on bankruptcy prediction models such as that used to construct Coface's score (Vivet, 2004, for Belgium and see, for example, the review by Balcaen and Ooghe, 2006). However, privately-computed probability of default or credit scores such as Coface's are naturally less well-known. The aim of the score is to predict the risk of default of the firm and therefore classify firms between "healthy" and "failing firms". The precise model used to compute the Coface score is confidential, for obvious reasons. As summarised in Figure 1, it combines several quantitative and qualitative inputs: financial statements (leverage, liquidity, profitability, size, etc.), industry-specific variables, macro-economic variables such as industrial production, legal form, age, geographical location, type of annual accounts (full or abbreviated), life cycle, board structure, commercial premises, payments incidents, ONSS (social security) summons and legal judgments.

These various inputs are combined using several statistical methods. This combination has been constructed by a trial-and-error method, which is why no Coface data before 1999 is used.

The result is a score ranging from 3/20 to 19/20. Although the model predicts continuous scores they are rounded to unity in the obtained data. The three categories used by Coface are the "maximum mistrust" (3 to 6/20 inclusive), "temporary vulnerability" (7 to 9/20 inclusive) and "normal to strong confidence" (10 to 19/20 inclusive).

Figure 1: The Coface Score



Selection of firms with a score

Given there is no possibility for the moment to select which firms' scores are available, below descriptive statistics are examined to see if there are any systematic differences between firms with a Coface score and those without. Table 1 shows that firms with a Coface score are larger and more productive[7]. Exporting firms with a score available export on average more, more products and to more destinations. However, given the high correlation between size and these variables, a Probit analysis is carried out for the year 2003.

Table 1: Comparison of firms with or without available Coface score

		No Coface score				Coface score available			
		Mean	sd	Obs.	se	Mean	sd	Obs.	se
Employment		12.95	123.28	39092	0.62	53.92	219.63	62416	0.88
Log of TFP Lev-Pet		9.95	1.31	37889	0.01	10.50	1.43	61655	0.01
EXPORTERS	Total export value (in million Euros)	7.80	12.20	6819	0.15	12.53	16.42	29585	0.10
	Number of destinations	8.11	15.29	6819	0.19	13.51	23.16	29585	0.13
	Number of products	8.22	58.37	6819	0.71	16.59	102.92	29585	0.60

Notes: The dataset is an unbalanced panel of Belgian manufacturing firms from the BBSTTD in 99 three-digit sectors for the years 1999 to 2005. The first four columns depict firms that have no Coface score available. The firm is however in the BBSTTD (with balance sheet information, more than one employee and potentially trade data) for that year. The Coface score is a credit-rating score constructed for each year and each firm by Coface. In the four last columns, the score is available. Only firms for which a score is available for each year they file a balance sheet over the period are kept in the sample. The mean, standard deviation (sd), number of observations (Obs.) and standard error of the means (se) are reported for the following variables. Employment represents the number of full-time equivalent employees, "Log of TFP Lev-Pet" is the logarithm of Total Factor Productivity calculated according to Levinsohn and Petrin's (2003) method. The last three rows compare exporters in each category, comparing the total value of their exports, the number of destinations they serve and the number of products they export.

[7] Their mean employment and mean productivity are significantly different from those of firms with no Coface score available, as can be seen by the size of the standard errors.

The results are reported in Table 2. Larger firms in terms of employees numbers are more likely to be included in the sample. This is not surprising given the nature of the score and the composition of the BBSTTD. In comparison to other papers in the literature (e.g. Bernard and Jensen, 2004), the requirement for all firms in Belgium to file a balance sheet implies that the annual accounts dataset contains a high proportion of very small firms. Despite the bias introduced by selecting only firms with a score, the resulting dataset remains representative of the Belgian economy in terms of sector composition, employment and value added growth[8]. Besides, Table 2 shows that once size of the firm is controlled for, there are no systematic differences between firms that are in the sample and those outside, given that the coefficients on productivity and export characteristics are not significant. So, there is no bias to be taken into account in the empirical analysis as long as size is controlled for.

Table 2: Probit analysis of inclusion in the Coface sample

Dependent variable:	0/1 dummy: 1 = Firm with Coface score available 0= no score available	
	(1)	(2)
Log (employment)	0.768**	0.377**
	(0.022)	(0.025)
Log (TFP Lev-Pet)	-0.013	
	(0.013)	
Exporter – non-Exporter dummy	-0.046	
	(0.031)	
Log (total exports)		-0.008
		(0.013)
Log (number of destinations exported)		0.007
		(0.031)
Log (number of products exported)		-0.024
		(0.025)
Observations	13924	5126

Notes: The dataset is an unbalanced panel of Belgian manufacturing firms from the BBSTTD in 99 three-digit sectors for the year 2003. Robust standard errors in parentheses; + denotes statistical significance at the 10% level; * denotes statistical significance at the 5% level; ** denotes statistical significance at the 1% level. Includes constant, not reported. The dependent variable is the a dummy equal to 1 if a credit rating score constructed for each firm by Coface is available in 2003. The dummy is equal to 0 if the firm is in the BBSTTD (with balance sheet information, more than one employee and potentially trade data), but no score is available. Only firms for which a score is available for each year they file a balance sheet over the period are kept in the sample. Log (x) is the logarithm of variable x. "TFP Lev-Pet" is Total Factor Productivity calculated according to Levinsohn and Petrin's (2003) method. "Exporter-non Exporter" is a dummy equal to 1 if the firm exports in 2003, and equal to 0 if not.

3.2.2 External validation

Having described the construction of the Coface score, this section now shows how it is correlated to firm fundamentals and how it is related to higher debt. It also relates it to the important literature on credit constraints in corporate finance.

Correlation with firm fundamentals Given the methodology used to construct the score is not available publicly, it is shown here how correlated the score is with the firm's financial situation and productivity. A selection of financial ratios (Lagneaux and Vivet, 2006) measures each firm's solvency, liquidity, profitability and investment.

Profitability is measured with the return on equity (ROE) ratio, net profit after tax over equity capital. It reflects the return to be expected by shareholders once all expenses

[8] In 2004, the firms with a score available represented 87.73 p.c. of total employment in manufacturing firms and 87.9 p.c. of total value added produced by manufacturing firms. It also contributed by 152 p.c. to the increase in total value added, while firms not included in the Coface sample reduced the total value added by 50 p.c.

and taxes have been deducted. It is widely used in the literature as an indicator of firm performance (see, for instance, Gorton and Schmid, 2000).

Table 3: The correlation between the score and financial ratios and productivity

Dependent variable:	Score						
	(1)	(2)	(3)	(5)	(6)	(7)	(8)
Return on equity	-0.395**						
	(0.033)						
Financial independence		5.267**					
		(0.114)					
Borrowings coverage			0.638**				
			(0.075)				
Broad liquidity				0.319**			
				(0.019)			
Investment ratio					80.381**		
					(9.268)		
Log (TFP Lev-Pet)						1.155**	0.056+
						(0.029)	(0.034)
Log (employment)	0.660**	0.734**	0.667**	0.734**	0.686**	0.363**	0.650**
	(0.043)	(0.043)	(0.044)	(0.045)	(0.045)	(0.016)	(0.044)
Observations	61237	61245	61190	61185	60114	61655	61655
Number of firms	10525	10452	10500	10485	10453		10477
R-squared	0.08	0.30	0.16	0.14	0.08	0.10	0.01
Firm fixed effects	YES	YES	YES	YES	YES	NO	YES
Sector fixed effects	NO	NO	NO	NO	NO	YES	NO
Year fixed effects	YES	YES	YES	YES	YES	YES	YES

Notes: Fixed-effect OLS regression ("Within" estimator). The dataset is an unbalanced panel of Belgian manufacturing firms from the BBSTTD with Coface score available and includes an average of 8,926 firms per year in 99 three-digit sectors over the period 1999 to 2005. Robust standard errors in parentheses; + denotes statistical significance at the 10% level; * denotes statistical significance at the 5% level; ** denotes statistical significance at the 1% level. Includes constant and 3-digit sector and year dummies, not reported. The ratios are defined as follows: Return on Equity = Net profit after tax / Equity capital; Financial independence = Equity capital / Total liabilities; Coverage of borrowings by cash flow = Cash flow / (Debt + Reserves + Deferred tax); Liquidity "in the broad sense" = (Total assets – Long-term Loans) / Short-term liabilities; Investment ratio = Acquisitions of tangible fixed assets / Value added. The extreme observations (top and bottom percentile) for each ratio across all years are removed for the corresponding regression.
Log (TFP Lev-Pet) is the logarithm of a measure of Total Factor Productivity measured according to Levinsohn and Petrin's (2003) method, for more details see main text in following section Log (employment) is the logarithm of employment, and makes it possible to control for the size of firms. The dependent variable is the credit rating score constructed for each year and each firm by Coface and ranges from 3 to 19. Only firms for which a score is available for each year they file a balance sheet over the period are kept in the sample. The variation in the number of observations is due to firms not reporting some of the variables used in the calculation of a given ratio in their balance sheet.

Solvency is measured with two ratios, financial independence and coverage of borrowings by cash flow. These summarise the firm's ability to meet its short- and long-term financial liabilities. Financial independence is the ratio between equity capital and total liabilities. It also reflects how independent the firm is of borrowings. The coverage of borrowings by cash flow measures the firm's repayment capability, and its converse specifies the number of years it would take to repay its debts assuming its cash flow were constant.

Liquidity "in the broad sense" ratio is used to assess the firm's ability to repay its short-term debts. It divides total assets realisable and available by short–term liabilities.

Investment is assessed by computing the rate of investment and acquisitions of tangible fixed assets over value added for the year.

As shown in Table 3, the Coface score is correlated with all these ratios, confirming it reflects the financial situation. The negative coefficient of the return on equity corresponds to a very low beta coefficient[9] (-0.015) compared to the other ratios (for example, 0.47 for financial independence). Also called standardised coefficients, the beta coefficents are computed by standardising the variables so that they have a variance of 1. The betas measure the effects on the dependent variable of the different independent variables. They allow the

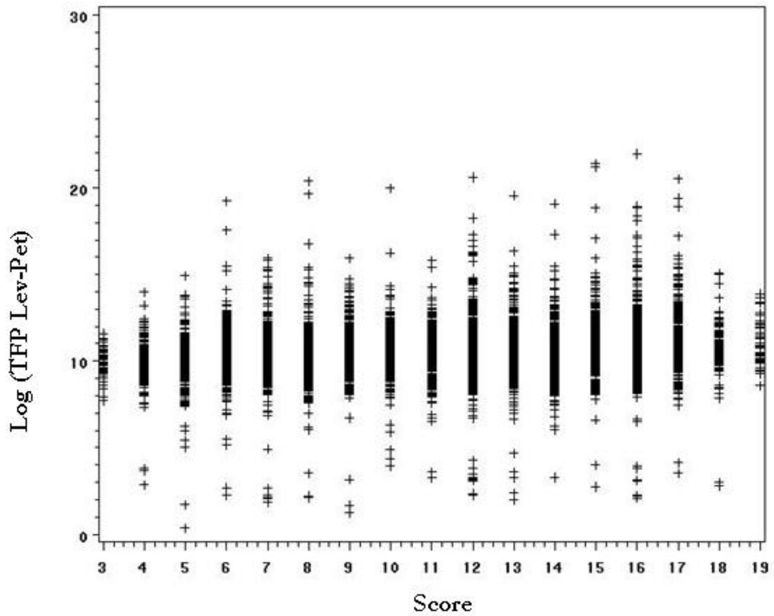
[9] The beta coefficients are not presented in the table and were computed separately.

comparison of the importance of the independent variables even when these are measured in different units. Liquidity and solvability therefore appear to be more important elements than profitability in determining a firm's access to credit. Firm and year fixed effects are included in the OLS regression, thus also controlling for possible differences in, for example, risk premia across industries and years which might affect the Coface score and other financial measures differentially. Such controls will be included in many other regressions in the paper.

Score and productivity This subsection also presents the correlation between credit constraints and productivity, the two determinants in the model's framework of firms' export decisions. Measuring productivity is prone to several problems that have been dealt with in different ways in the literature. The method used throughout this paper, as in Levinsohn and Petrin (2003), measures TFP using materials as a proxy rather than investment, thus reducing the number of zero-observations often noted in the data for investment compared to materials[10].

In Table 3, the Coface score is regressed on productivity, controlling for size, and including separate specifications with sector and firm fixed-effect in the two last columns. Score is positively but not perfectly correlated with productivity, confirming that credit constraints and productivity are two different issues to be considered when analysing export behaviour. This is also illustrated in Figure 2, which shows there is no clear positive relationship between the score and the firm's productivity.

Figure 2: Total Factor Productivity and Score (2005)



Notes: The dataset is an unbalanced panel of Belgian manufacturing firms from the BBSTTD with Coface score available in each year they file in a balance sheet over the period and includes an average of 8,926 firms per year in 99 three-digit sectors over the period 1999 to 2005. This figure plots 8,395 firms for the year 2005. On the horizontal axis, the credit rating score is reported, constructed for each year and each firm by Coface and ranges from 3 to 19. The vertical axis measures the logarithm of Total Factor Productivity computed according to Levinsohn and Petrin's (2003) method.

Dividend Payout and Total Assets The effects of financial constraints on firm behaviour are an important area of research in corporate finance. Compared with existing literature, the Coface score provides many advantages. It is a direct measure of the credit ratings of firms,

[10] The results presented below are robust to using alternative measures of Total Factor Productivity.

which is used by banks and other firms when they decide to extend credit or not. Adapted according to the most recent information available and including many determinants, it is available for each year. Finally, it not only classifies firms between constrained and non-constrained, but provides a precise scale of the creditworthiness of the firm.

One of the many approaches in the literature consists of sorting firms into financially-constrained and unconstrained types on a yearly basis by ranking firms according to their payout dividend ratio (Cleary, 1999). As in Almeida et al (2004) and based on the intuition in Fazzari et al. (1988), firms in the top three deciles would be considered as less financially-constrained than firms in the bottom three. Also, considering size as a good observable measure of credit constraints based on Gilchrist and Himmelberg (1995) and as in Almeida et al. (2004), ranking can be made according to total assets (Allayannis and Mozumdar, 2004). Testing whether such classifications imply a larger score for unconstrained firms, the results are presented in Table 4. In the two alternative classification criteria, it appears that unconstrained firms will have a significantly higher average score than financially-constrained ones. The means are significantly different from one another, as can be noted from the standard errors. This confirms that the Coface score offers a creditworthiness measure that is consistent with the existing literature.

Table 4: Score of financially-constrained and unconstrained firms according to dividend payout ratio and total assets

Score	Mean	SE	Max	Min	N
Dividend payout					
Constrained	13.52	.054	19	3	3074
Unconstrained	14.12	.048	19	3	3073
Total assets					
Constrained	10.33	.028	19	3	18762
Unconstrained	13.00	.027	19	3	18767

Notes: The dataset is an unbalanced panel of Belgian manufacturing firms from the BBSTTD with Coface score available and includes an average of 8,926 firms per year in 99 three-digit sectors over the period 1999 to 2005. The credit rating score constructed for each year and each firm by Coface ranges from 3 to 19. Its mean, standard error, maximum and minimum observations are reported for the different categories defined. Using the dividend payout criterion, only firms whose dividend payout is positive are included, which is why there is a difference in the number of observations. Firms whose dividend payout is in the top 30 percentiles are considered as financially unconstrained, whereas those in the bottom 30 percentiles are financially constrained. The same is done with total assets. The mean test is passed, meaning that constrained firms have a lower score than unconstrained firms, in both criteria. This is robust to using only one cross-section of the data, or taking out observations within the top and bottom percentiles of each measure.

4 Empirical results

In this section the predictions of the model will be tested on the Belgian dataset. It should be noted that the necessary and simplifying assumption made in equation 17 that prices are set domestically does not apply perfectly to an open economy such as Belgium, used in the empirical section below. However, the predictions of the model tested in this section remain valid.

4.1 The effect of credit constraints on the export status, destinations, total exports, and products.

As a first prediction of the model, it would be expected that firms that are less credit-constrained are more likely to be exporters. This appears in the descriptive statistics presented in Table 5: on average, exporters are not only significantly larger and more productive, they also have a significantly higher score, meaning they are more creditworthy and less liquidity-constrained.

Table 5: Descriptive Statistics

	Non-Exporters				Exporters			
	Mean	sd	Obs.	se	Mean	sd	Obs.	se
Employment	15.89	31.11	33425	0.17	97.45	314.65	29036	1.85
Log of TFP Lev-Pet	10.23	1.10	32769	0.01	10.80	1.66	28860	0.01
Score	11.06	3.78	33425	0.02	12.32	3.84	29036	0.02
Number of destinations					12.74	16.48	29036	
Number of products					13.75	23.32	29036	
Total export value (in million Euros)					16.90	104.0	29036	

Notes: The dataset is an unbalanced panel of Belgian manufacturing firms from the BBSTTD with Coface score available and includes an average of 8,926 firms per year in 99 three-digit sectors over the period 1999 to 2005. Observations are at the firm-year level. The credit rating score constructed for each year and each firm by Coface ranges from 3 to 19. The means, standard deviations, numbers of observations and standard errors of means are reported for the different variables and categories defined. Exporters are firms that were exporting a positive amount in that year. Non-exporters were exporting zero in that year.

This is confirmed when considering the coefficients of firm characteristics effect on the probability of exporting in a given year from the linear probability model in levels reported in Table 6. The whole sample of firms for which a Coface score is available in each year it has filed a balance sheet is included. Given the number of fixed effects to be included in the specification, using a linear probability model addresses the incidental parameters problem that affects non-linear fixed-effects estimates. This specification is used in Bernard and Jensen (2004) for a very similar binary choice problem despite the problems this might provoke (e.g. predicted probabilities outside the 0-1 range). Dummies for three-digit industry and year are included, and control for lagged (one year) size and a measure of productivity: total factor productivity (as in Levinsohn and Petrin). Controlling for these observables and given the composition of the score described above, the residual is a good measure of credit constraints faced by a firm. Larger and more productive firms are more likely to be exporting. The first column replicates the result previously found in the literature that more productive firms are more likely to export. The coefficient on the lagged score is positive and significant in column (2), confirming that firms which are less credit-constrained have a higher probability of being exporters. In that specification, the coefficient on productivity is not reduced compared to the first column, indicating the score captures the additional effect of credit constraints. The score is also included in column (3) which augments the model with an interaction term between the lagged score and lagged TFP. Probably due to the correlation between productivity and the score which reduces the significance of the variables, the result is not as predicted by the model. The positive effect of a higher credit score on the probability to be an exporter is not diminished with a higher productivity. When including the lagged export status variable, as in Bernard and Jensen (2004), the results carry through although the positive coefficient on the score is not significant, as shown in columns (4) and (5). This is probably due to firms' scores not varying much through time, as creditworthiness might not change greatly from year to year. It could also point to the results of the model showing that credit constraints should have no impact on a firm's exporting status in a given year if it was already an exporter in the previous year as the fixed cost of starting to export would have already been borne.

Table 6: Linear probability model on exporter status

Dependent variable:	0/1 Dummy non-exporter/exporter				
	(1)	(2)	(3)	(4)	(5)
Log (Score (t-1))		0.027**	0.016	0.004	0.001
		(0.005)	(0.035)	(0.003)	(0.004)
Log (TFP Lev-Pet (t-1))	0.090**	0.087**	0.085**	0.013**	0.026**
	(0.004)	(0.004)	(0.009)	(0.002)	(0.004)
Log (TFP Lev-Pet (t-1)) x Log (Score (t-1))			0.001		
			(0.003)		
Exporter/non-exp. (t-1)				0.782**	0.106**
				(0.004)	(0.010)
Log (empl.) (t-1)	0.143**	0.142**	0.142**	0.032**	0.067**
	(0.002)	(0.002)	(0.002)	(0.001)	(0.005)
Observations	50824	50824	50824	50824	50824
R-squared	0.33	0.33	0.33	0.74	0.02
Number of firms					10080
Firm fixed effects	NO	NO	NO	NO	YES
Year fixed effects	YES	YES	YES	YES	YES
Sector fixed effects	YES	YES	YES	YES	NO

Notes: Linear Probability regression in levels for columns (1) to (3) and with firm fixed effect ("Within" estimator) for column (4). The dataset is an unbalanced panel of Belgian manufacturing firms from the BBSTTD with Coface score available or each year they file in a balance sheet over the period and includes an average of 8,926 firms per year in 99 three-digit sectors over the period 1999 to 2005. Robust standard errors in parentheses; + denotes statistical significance at the 10% level; * denotes statistical significance at the 5% level; ** denotes statistical significance at the 1% level. Includes constant and 3-digit sector and year dummies, not reported. The dependent variable is a dummy indicating whether the firm exports or not in that year. (t-1) indicates the explanatory variable has been lagged by one year. Log (x) is the logarithm of variable x. The credit rating score, constructed for each year and each firm by Coface ranges from 3 to 19. Log (empl.) is the logarithm of employment, and makes it possible to control for the size of firms. TFP Lev-Pet is a measure of Total Factor Productivity calculated according to Levinsohn and Petrin's (2003) method. For column (3), the interaction between productivity and the score is used as an explanatory variable. In columns (4) and (5), the lagged dependent variable, a dummy indicating export activity in the previous year, is also included.

As regards destinations, Proposition 2 considers the number of destinations served by a firm as being positively related to its productivity and negatively to credit constraints. This is confirmed in the OLS regression with firm fixed effects in the first column of Table 7, where it appears that the lagged score affects positively and significantly the number of markets served by a firm, while the positive coefficient on productivity is significant[11]. Going beyond the model, it is also established in Table 7 that this result is also true when looking at total exports and products. The number of products exported seems to be less dependent on credit constraints (the positive coefficient is only statistically significant at the 10.2% level) than the number of destinations.

[11] This is robust to using the logarithm of labour productivity measured by value added per employee, rather than TFP.

Table 7: Total exports, destinations and products

Dependent variable:	Log (Number of destinations) (1)	Log (Total exports) (2)	Log (Number of products exported) (3)
Log (Score (t-1))	0.036**	0.088**	0.024+
	(0.011)	(0.026)	(0.014)
Log (TFP Lev-Pet (t-1))	0.028**	0.147**	0.028*
	(0.010)	(0.024)	(0.011)
Log (Employment (t-1))	0.311**	0.757**	0.314**
	(0.019)	(0.047)	(0.023)
Observations	22137	22137	22137
Number of firms	4972	4972	4972
R-squared	0.04	0.05	0.02
Firm fixed effects	YES	YES	YES
Year fixed effects	YES	YES	YES

Notes: Fixed-effect OLS regressions ("Within" estimator). The dataset is an unbalanced panel of Belgian manufacturing firms from the BBSTTD with Coface score available or each year they file in a balance sheet over the period and includes an average of 8,926 firms per year in 99 three-digit sectors over the period 1999 to 2005. Only observations in which the firm is exporting are kept. Robust standard errors in parentheses; + denotes statistical significance at the 10% level; * denotes statistical significance at the 5% level; ** denotes statistical significance at the 1% level. Includes constant and year dummies, not reported. The dependent variables are the logarithms of the number of destinations served (column (1)), of total exports (column (2)) and of the number of different 8-digit (CN nomenclature) products exported (column (3)) by a firm in one year. (t-1) indicates the explanatory variable has been lagged by one year. Log (x) is the logarithm of variable x. The credit rating score, constructed for each year and each firm by Coface ranges from 3 to 19. Log (empl.) is the logarithm of employment, and makes it possible to control for the size of firms. TFP Lev-Pet is a measure of Total Factor Productivity calculated according to Levinsohn and Petrin's (2003) method.

These results clearly establish the relationship that exists between credit constraints and exporting behaviour, even once productivity and size are controlled for. They confirm the equilibrium relationship identified in the model holds empirically. The next section aims at improving these results by analysing the interactions through time.

4.2 The effects of credit constraints over time

4.2.1 Becoming an exporter

In order to assess the importance of credit constraints in the decision to start exporting, Table 8 reports the effects of lagged firm characteristics on the probability of being a new exporter. New exporters are defined as firms that have not exported in any of the three previous years of the sample. Firms that export throughout the sample are excluded, as are those observations for new exporters in subsequent years. The alternative to being a new exporter is a firm that does not export that year. A linear probability estimator with year and firm fixed effects is used to estimate the probability of starting to export, with TFP and employment as explanatory variables. Productivity affects positively the probability of becoming an exporter the following year. When including the lagged score as a measure of credit constraints, its effect is insignificantly positive, and the coefficients on the other two variables are unchanged.

Table 8: New exporters

Dependent variable:	(1) 0/1 Dummy new exporter	(2) 0/1 Dummy new exporter
Log (Score (t-1))		0.003
		(0.004)
Log (TFP Lev-Pet (t-1))	0.010*	0.010**
	(0.004)	(0.004)
Log (Employment (t-1))	0.024**	0.024**
	(0.004)	(0.004)
Observations	25757	25757
R-squared	0.02	0.02
Firm fixed effects	YES	YES
Year fixed effects	YES	YES

Notes: Fixed-effect OLS regressions ("Within" estimator). The dataset is an unbalanced panel of Belgian manufacturing firms from the BBSTTD with Coface score available for each year they file in a balance sheet over the period and includes an average of 8,926 firms per year in 99 three-digit sectors over the period 1999 to 2005. Robust standard errors in parentheses; + denotes statistical significance at the 10% level; * denotes statistical significance at the 5% level; ** denotes statistical significance at the 1% level. Includes constant and 3-digit sector and year dummies, not reported. The dependent variable is a dummy indicating whether the firm is a new exporter or not in that year. Being a new exporter is defined as a firm that did not export in any of the three previous years in the sample and did export that year. Firms that export every year in the sample are dropped. Firms that were new exporters in a previous year are dropped. (t-1) indicates the explanatory variable has been lagged by one year. Log (x) is the logarithm of variable x. The credit rating score, constructed for each year and each firm by Coface ranges from 3 to 19. TFP Lev-Pet is a measure of Total Factor Productivity measured according to Levinsohn and Petrin's (2003) method. Log (Employment) is the logarithm of employment, and makes it possible to control for the size of firms.

One potential explanation for this result is that firms that have never exported and start exporting do not use external credit to overcome the fixed cost of exporting to their first destination. They will rely instead on internal liquidity, corresponding to the exogenous liquidity shock in the theoretical model. It may also be the case that Belgium being an open and small country, starting to export close to its borders is not very costly for firms, compared to the fixed cost of expanding to markets further away. This is why the next section concentrates on export destinations.

4.2.2 Extensive and intensive margin for destinations

Having considered the decision on starting to export, the effect of credit constraints on the decision to export to more destinations is now examined. This is the extensive margin of exports to a given destination. According to the theoretical model, credit constraints should matter for the decision of existing exporters to start exporting to a new country. It should not, however, affect the value of exports per destination or its subsequent increases, namely the intensive margin. Adopting a linear probability specification, the probability of an exporter increasing the number of countries it serves is positively affected by size, productivity and a higher score (and hence weaker credit constraints). Once firm fixed effects are controlled for, as reported in the first column of Table 9, only the coefficient on the score remains significantly positive. When compared to the results presented in the previous section, this would suggest that credit constraints are more important in determining the increase in the number of destinations served than in explaining the decision to start exporting. The table also reports in the OLS regression of the second column that the actual increase in the number of destinations served relative to the previous year is also positively related to creditworthiness. Turning to the intensive margin of trade to a given destination, it appears in the third column of Table 9 that credit constraints have no effect on the increase in the value of exports to a given destination, as the coefficient on the lagged Coface score is insignificant.

This is consistent with the results of the model, as credit constraints affect the ability of firms to cover the fixed cost of exporting to an additional destination. Once the fixed cost has been borne, the amount exported to that destination is not dependent on the availability of credit.

The negative coefficients on productivity and employment when firm fixed effects are included, though not very significant in the first column, are surprising. They could reflect the fact that it is the smallest and less productive exporters that expand their number of destinations and value per destination most, while other more successful exporters are already well established in the different countries they serve.

Table 9: The extensive and intensive margins per destination

Dependent variable:	Increase in number of destinations		Increase in logarithm of mean value per destination
	0/1 Dummy no increase/ increase	Increase in Log (Number of destinations served)	
	(1)	(2)	(3)
Log (Score (t-1))	0.038*	0.037**	0.034
	(0.017)	(0.014)	(0.028)
Log (TFP Lev-Pet (t-1))	-0.006	-0.022*	-0.091**
	(0.012)	(0.010)	(0.021)
Log (Employment) (t-1)	-0.035+	-0.037+	-0.116**
	(0.020)	(0.021)	(0.039)
Observations	20097	19835	20097
Number of firms	4889	4827	4889
R-squared	0.01	0.01	0.01
Firm fixed effects	YES	YES	YES
Year fixed effects	YES	YES	YES

Notes: Linear Probability (column (1)) and OLS (columns (2) and (3)) regressions with firm fixed effect ("Within" estimator). The dataset is an unbalanced panel of Belgian manufacturing firms from the BBSTTD with Coface score available or each year they file in a balance sheet over the period and includes an average of 8,926 firms per year in 99 three-digit sectors over the period 1999 to 2005. Only observations in which the firm is exporting are kept. Robust standard errors in parentheses; + denotes statistical significance at the 10% level; * denotes statistical significance at the 5% level; ** denotes statistical significance at the 1% level. Includes constant and year dummies, not reported. The first column's dependent variable is a dummy equal to 0 if the firm did not increase the number of destination it exports to relative to the previous year. The dependent variable for column two is the increase in the logarithm of the number of destinations relative to the previous year. The first year a firm starts exporting is dropped from the sample. In column (3), the dependent variable is the increase in the logarithm of the mean value per destination. This mean value is per firm, per year, how much (in Euros) it exports on average to each of its destinations. (t-1) indicates the explanatory variable has been lagged by one year. Log indicates the logarithm of the variable has been used. The credit rating score, constructed for each year and each firm by Coface ranges from 3 to 19. TFP Lev-Pet is a measure of Total Factor Productivity measured according to Levinsohn and Petrin's (2003) method. Log (Employment) is the logarithm of employment, and makes it possible to control for the size of firms.

4.3 Pecking order of trade

Proposition 3 shows how firms will follow a pecking order of trade when adding export destinations to their portfolio: more productive firms will export to more destinations, as shown above, and to smaller markets (weighted by the trade cost). This result holds in the data, as presented in Table 10. The trade cost weighted market size of each country in each year of the sample is constructed as the Gross Domestic Product[12], divided by a measure of distance from Belgium. GDP is taken as a proxy for L^*, the market size in the model, as it represents the market potential of a country. Distance is taken as a measure of trade costs, as

[12] The data used is that of the US Census Bureau International Database (www.census.org).

it will be more costly for firms to ship goods to markets that are further away. Following Head and Mayer (2002) and Mayer and Zignano (2006), the distance is weighted by the geographic distribution within the country. This is measured by the share of the main city's population in the country's population and will reflect the trade cost of reaching the consumers around the country. For a given GDP, the further the country, the smaller its trade cost weighted market size. Similarly, between two equidistant markets, the larger in terms of GDP will be of a bigger size. For each firm in each year, the smallest market it exports to is selected, as an indicator of how far down the pecking order a firm is situated. The logarithm of the trade cost weighted market size of that country is the dependent variable. The first specification in Table 10, an OLS regression with sector and year fixed effect shows how more productive firms export to smaller countries. The second column shows this result is robust to including financial constraints: less credit-constrained firms will go further down the pecking order of trade. When introducing firm fixed effects in the third column, the effects of productivity and credit constraints are no longer significant, yet this is probably due to firms not varying strongly from year to year the furthest market they manage to reach.

These results confirm that the equilibrium relationship between productivity, credit constraints and market potentials of destinations identified in Proposition 3 of the model holds in the data.

Table 10: Market size, productivity and credit constraints

	Log (GDP/Weighted Distance) of smallest destination		
	(1)	(2)	(3)
Log (Score (t-1))		-0.102*	-0.044
		(0.051)	(0.050)
Log (TFP Lev-Pet (t-1))	-0.494**	-0.483**	-0.033
	(0.035)	(0.036)	(0.040)
Log (Employment) (t-1)	-0.603**	-0.600**	-0.523**
	(0.019)	(0.019)	(0.066)
Observations	20026	20026	20026
R-squared	0.26	0.26	0.01
Number of firms			4882
Firm fixed effects	NO	NO	YES
Sector fixed effects	YES	YES	NO
Year fixed effects	YES	YES	YES

Notes: OLS regressions, with firm fixed effect ("Within" estimator) for the third specification in column (3). The dataset is an unbalanced panel of Belgian manufacturing firms from the BBSTTD with Coface score available or each year they file in a balance sheet over the period and includes an average of 8,926 firms per year in 99 three-digit sectors over the period 1999 to 2005. Only observations in which the firm is exporting are kept. Robust standard errors in parentheses; + denotes statistical significance at the 10% level; * denotes statistical significance at the 5% level; ** denotes statistical significance at the 1% level. Includes constant and year and sector dummies, not reported. The dependent variable for all three regressions is the logarithm of the GDP-distance ratio, where the distance is weighted according to the share of the main city's population in the country's total population. (t-1) indicates the explanatory variable has been lagged by one year. Log indicates the logarithm of the variable has been used. The credit rating score, constructed for each year and each firm by Coface ranges from 3 to 19. TFP Lev-Pet is a measure of Total Factor Productivity measured according to Levinsohn and Petrin's (2003) method. Log (Employment) is the logarithm of employment, and makes it possible to control for the size of firms. Source: GDP from US Census Bureau International Data, Weighted distance from CEPII.

4.4 Exchange rates

The last result of the theoretical section of this paper relates to credit constraints and the sensitivity of trade flows to relative wage fluctuations. An increase in domestic relative to foreign wages corresponds to a loss of competitiveness of domestic exporters, as would occur following a domestic currency appreciation. The effects of exchange rates on aggregate trade flows have been shown in the literature to be mostly insignificant (see McKenzie (1999) for a overview). However, as shown in Proposition 4 of the model presented in section 1, this could be due to various effects at play at the firm level that cancel each other out in the aggregate. The first effect of a domestic currency appreciation (depreciation) with respect to a given country is that existing exporters to that destination will respond with a decrease (increase) in their volume of exports. This is tested in the data by selecting firms that already exported in the previous year to a given destination, and considering their response to a change in exchange rates. The results are reported in the first column of Table 11. Controlling for productivity and size, an appreciation (depreciation) of the domestic currency decreases (increases) the market shares of existing exporters to a given destination, as put forward by point (i) of Proposition 4. This is robust to controlling for credit constraints, as the score's effect is then insignificant and doesn't affect the other variables' coefficients.

The second effect of an appreciation is that the least productive exporters to that country can no longer export profitably and are consequently forced out of the market. A depreciation would rather make those exporters gain competitiveness and reinforce their position in that market, which is why we only consider appreciation episodes. In the data, one can compare the productivity of firms that keep on exporting to a given destination, even after a domestic currency appreciation episode, with that of firms which stop exporting. The result of a linear probability model with fixed effects is presented in Table 11's second column. Productivity at the firm and year level is summarised by a dummy reflecting low productivity, as it is equal to one when Total Factor Productivity is lower than the year-three-digit-sector median. Being of the low productivity type will increase the probability of an exporter exiting the market it used to serve following a domestic currency appreciation episode vis-à-vis this country's currency.

The third effect presented in point (iii) of Proposition 4 is that the most productive non-exporters that could not start exporting because they were liquidity-constrained will now be able to do so, because the fixed entry cost has decreased in terms of domestic currency. This is tested by considering only appreciation episodes, given that with a depreciation of the domestic currency, the fixed cost would increase. Existing exporters are more likely to start exporting to a destination whose exchange rate has depreciated (i.e. for Belgian firms, the euro has appreciated) in the past year if they were productive but credit-constrained in the previous year. This is shown in the last column of Table 11 where the dependent variable is a dummy that is equal to one when the firm started exporting to at least one destination that experienced an exchange rate depreciation with respect to the previous year. It is equal to zero if the firm, an existing exporter, did not add to its portfolio of served markets any destination with an exchange rate depreciation episode relative to the previous year. Credit-constrained firms are those whose score is lower than the three-digit-sector-year median. They are less likely to start exporting following a domestic currency appreciation. This is reflected in the significantly negative coefficient on the credit constraint dummy. The positive and significant coefficient on the interaction between TFP and credit constraint reflects the relationship shown in the theoretical model that the most productive of the constrained firms are now less credit-constrained and able to overcome the fixed cost of profitably exporting to those destinations. Note that in all three columns of Table 11 , and as in Table 9, the coefficient for productivity is negative and significant. As mentioned above, this could be due to smaller and less productive firms expanding their exports most, and should be explored in future research.

These results confirm that the last proposition of the theoretical model is not contradicted by the data when considering the relationship between exchange rate movements and firm-level exporting behaviour.

Table 11: Effect of exchange rate movements on firm-level export patterns

	(1)	(2)	(3)
Dependent variable:	Change in logarithm of value exported per destination	0/1 dummy: 1 = exit from a given destination 0= continues exporting to a given destination	0-1 dummy of starting to export to at least one destination with recent Euro appreciation
% change in exchange rate	-0.234+		
	(0.129)		
Low productivity dummy		0.047*	
		(0.018)	
Credit constrained (t-1)			-1.456**
			(0.029)
Log(TFP Lev-Pet) x constrained (t-1)			0.112**
			(0.002)
Log (TFP Lev-Pet (t-1))	-0.027**		-0.069**
	(0.010)		(0.012)
Log (Employment (t-1))	-0.019	-0.163**	-0.034
	(0.020)	(0.026)	(0.021)
Observations	182914	13869	14172
R-squared	0.00	0.08	0.24
Number of firms	4457	2758	3707
Firm fixed effects	YES	YES	YES
Year fixed effects	YES	YES	YES
Destination fixed effects	YES	YES	NO

Notes: Fixed-effect OLS regressions ("Within" estimator). The dataset is an unbalanced panel of Belgian manufacturing firms from the BBSTTD with Coface score available or each year they file in a balance sheet over the period and includes an average of 8,926 firms per year in 99 three-digit sectors over the period 1999 to 2005. Only observations in which the firm is exporting are kept. Exchange rate data is obtained from the National Bank of Belgium Belgostat database. + denotes statistical significance at the 10% level; * denotes statistical significance at the 5% level; ** denotes statistical significance at the 1% level. Includes constant, destination and year dummies, not reported. TFP Lev-Pet is a measure of Total Factor Productivity measured according to Levinsohn and Petrin's (2003) method. Log (Employment) is the logarithm of employment, and makes it possible to control for the size of firms.
In the first column, the dependent variable is the change with respect to the previous year in the logarithm of the value exported to a given destination, if the firm already exported there the previous year. Cases in which it is a new destination the firm exports to are dropped. The result is robust to dropping Euro-zone destinations in which the exchange rate did not vary. Clustered (year x destination) standard errors are reported in parenthesis.
In the second column, destinations are only kept for the years they have experienced an appreciation vis-à-vis the Euro. Robust standard errors in parentheses. The dependent variable reflects firm exit from a market. It is a dummy set to 1 if the firm had been exporting to the given destination for at least two years and stopped for that year and the following year at least. If they are still exporting to the given destination that year and the following the dummy is set to 0. Other observations are dropped. The "low productivity dummy" explanatory variable is a dummy set equal to 1 when the TFP measure à la Levinsohn and Petrin is below the year and three digit sector median, and zero otherwise. The result is robust to using the TFP measure itself.
In the third column, as in the second, destinations-years are only kept if the Euro has experienced an appreciation vis-à-vis its exchange rate. Robust standard errors in parentheses. The dependent variable is a dummy which is equal to 1 if, in that year, the firm, that was already an exporter in the previous year, started exporting to at least one destination that had experienced an appreciation of its exchange rate. It is equal to zero if the exporter did not start exporting to any destination that had experienced an appreciation of its exchange rate. The explanatory variables are a measure of the logarithm of TFP à la Levinsohn and Petrin (2003), a credit-constraint dummy equal to 1 if the score is below the year-3-digit-sector median, and the interaction between TFP and this dummy.

5 Conclusion

In this paper, it has been shown that credit constraints really do matter for export patterns. Using a very precise and complete dataset on export transactions at the firm level for the Belgian manufacturing sector, it is combined with an unusual and very useful yearly measure of credit constraints faced by firms, a creditworthiness score constructed independently by a credit insurer. These make it possible to examine the relationship between credit constraints and exports in a novel way. The main prediction of the model is that some firms could profitably export but are prevented from doing so by a lack of liquidity which stops them from reaching foreign markets. This is reflected in the data, where it is shown that firms are more likely to be exporting if they enjoy higher productivity levels and lower credit constraints. The second prediction of the model is that credit constraints are important in determining the extensive margin of trade in terms of destinations, that is the number of destinations a firm exports to and the decision of a firm to export to a new destination. The intensive margin of trade in that dimension, the average exports of a firm to the destinations it serves, should not be affected by credit constraints. This equilibrium derived from the model also holds in the data. Third, as derived in the model, firms follow a pecking order of trade, where more productive and less credit-constrained firms reach markets of smaller trade cost weighted market size. Finally, the model predicts that the sensitivity of trade flows to exchange rate variations is composed of several elements. An exchange rate appreciation will cause existing exporters to reduce their exports, entry of credit-constrained potential exporters and exit of the least productive exporters. All three effects appear in the data.

These results confirm the link between credit constraints and export patterns. They also highlight the potential role of institutions in determining, through their policies on credit constraints, the patterns of trade and hence the productivity levels and gains of productivity, and the overall welfare. As credit constraints matter, they establish a connection between the number of markets served by a firm and the growth of its exports, as additional liquidity obtained on one market may enable another one to be entered. Examining the dynamics of firm-level exports and how they relate to liquidity and productivity is an exciting area for future research.

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A Proof of Proposition 1

Proposition 1 (repeated): *If* $\left[\frac{C_d^*}{C_f}\frac{(1-\lambda)(1-t_s)C_d+\frac{w^*}{w}C_f}{\lambda\tau^{1-\sigma}\left(\frac{w^*}{w}\right)^{\sigma}C_d^*+(1-\lambda)\left(\frac{h(C_d)}{h(C_d^*)}\right)^{1-\sigma}C_d}\right]^{\frac{1}{\sigma-1}} > \frac{\tau w}{w^*}$, *there is a non-empty set of liquidity-constrained firms that are prevented from profitably exporting because they have insufficient liquidity, both exogenously and on the external financial market.*

Proof. All firms above $\overline{x}_f$ are productive enough to profitably export. Firms whose liquidity is lower than $\overline{x}(A)$ are not able to export, even if they could profitably do so, because they do not have sufficient liquidity to cover the fixed cost of exporting. Suppose $(A, x) \in \Omega$ iif $\overline{x}_f \leq x < \overline{x}(A)$. Firms in Ω are prevented from exporting because they are liquidity-constrained, despite being able to profitably do so. $\overline{x}(0) > \overline{x}_f$ is a necessary and

sufficient condition for Ω to be non-empty. Given equations (20) and (21), this will hold if $\left[\frac{C_d^*}{C_f}\frac{(1-\lambda)(1-t_s)C_d+\frac{w^*}{w}C_f}{\lambda\tau^{1-\sigma}\left(\frac{w^*}{w}\right)^\sigma C_d^*+(1-\lambda)\left(\frac{h(C_d)}{h(C_d^*)}\right)^{1-\sigma}C_d}\right]^{\frac{1}{\sigma-1}} > \frac{\tau w}{w^*}$. Then Ω is non-empty, and there are indeed firms that are liquidity-constrained. ■

B Proof of Proposition 3

Proposition 3 (recalled): *Firms will add export destinations in decreasing order of trade cost weighted market size, $\frac{L^*}{\tau^{\sigma-1}}$. More productive firms will export to more destinations, but also to relatively smaller markets.*

Proof. By earning higher revenues on a larger market, lower-productivity firms can export

to larger markets. Yet, the higher the iceberg cost of exporting to that destination, the lower the revenues on that market. Hence the productivity cut-off is lower for a larger trade cost weighted market: $\frac{\partial\overline{x}_n(A)}{\partial\frac{L^*}{\tau^{\sigma-1}}} < 0$. Besides, the relative ordering of countries with respect to the productivity threshold of firms exporting there remains the same. Therefore, a firm that increases the number of destinations it serves from n to $(n+1)$ will still export to the n largest (trade cost weighted) markets and add the next largest (trade cost weighted) market to its portfolio of trade partners. ■

C Proof of Proposition 4(3)

Proof. Given $\bar{x}(A)$ as in equation 21, the sign of $\frac{\partial\bar{x}(A)}{\partial\frac{w^*}{w}}$ depends on whether the following expression holds:

$$\left(\frac{\tau w}{w^*}\right)^{\sigma-1}\frac{1}{\lambda\sigma} > \frac{C_d^*}{C_f}\frac{(1-\lambda)(1-t_s)C_d+\frac{w^*}{w}C_f-(1-\lambda)A}{\lambda\tau^{1-\sigma}\left(\frac{w^*}{w}\right)^\sigma C_d^*+(1-\lambda)\left(\frac{h(C_d)}{h(C_d^*)}\right)^{1-\sigma}C_d} \tag{26}$$

Given that $\frac{(1-\lambda)A}{\lambda\tau^{1-\sigma}\left(\frac{w^*}{w}\right)^\sigma C_d^*+(1-\lambda)\left(\frac{h(C_d)}{h(C_d^*)}\right)^{1-\sigma}C_d}\frac{C_d^*}{C_f} \geq 0$, and assuming there is a non-empty set of liquidity constrained potential exporters such that the condition from Proposition 4.1 holds, then inequality will hold if:

$$\left(\frac{\tau w}{w^*}\right)^{\sigma-1}\frac{1}{\lambda\sigma} > \left(\frac{\tau w}{w^*}\right)^{\sigma-1}$$

As $\sigma > 1$ and the condition of Proposition 4.1 also implies that $\lambda < 1$, then the inequality of equation (26) holds and $\frac{\partial\bar{x}(A)}{\partial\frac{w^*}{w}} > 0$. ■

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