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Exporting and Firm-Level Credit Constraints – Evidence from Ghana

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March 2015

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I. Introduction

Compared to domestic production, exporting requires additional financing. For example, exporters may incur fixed costs of learning about foreign markets, advertising, and setting up a distribution network in the foreign markets. Exporters also have to cover additional variable costs associated with exporting, such as duties, shipping, and freight insurance. Because of long-distance shipping, the delay for exporters to receive order payments tends to be longer than for domestic producers. This implies that exporters have higher working capital requirements than domestic producers. Lenders may be more reluctant to finance exporting, since information about foreign markets and potential profitability is more difficult to obtain than for domestic sales. Payment enforcement is also more difficult in a foreign country, so exporters may face a higher risk of late payment or non-payment from clients.[1]

The trade and finance literature has documented the negative impacts of credit constraints on trade. However, most of this evidence comes from studies exploits the variation in financial development across countries and the variation in financial vulnerability across sectors. Financially developed countries export greater volumes, more products, and reach more export destinations. Furthermore, these patterns are more pronounced in financially vulnerable sectors, i.e. sectors with greater requirements for external capital, and sectors with few assets that can be collateralized (Manova 2008, 2013; Beck, 2002, 2003).

However, micro-evidence from firm data on the impact of credit constraint on exporting is still emerging and not as conclusive. Most studies support the hypotheses that credit constraint has a negative impact on exporting. For example, Correa et al. (2007) find that having loans increased Ecuadorian firms' exports and Muûls (2012) find that better credit scores increases both the extensive and intensive margins of exports, as well as the number of exported products and the number of export destinations. Zia (2008) utilizes a natural experiment: the Pakistani government's removal of subsidized export loans. Zia finds that privately owned firms experienced a significant decline in their exports, while large firms, firms in corporate networks, or firms that have relationship with multiple banks were less affected. Berman and Héricourt (2010) also find negative impact of financial constraint on the extensive margin of export using data for 5,000 firms in nine developing and emerging economies. However, Greenway, Guariglia and Kneller (2007) and Stiebale (2011) find no evidence that financial constraints affect export decisions.

My paper adds to the micro-evidence literature of the impact of financial constraint on trade. In this paper, I extend the models in Melitz (2003) and Chaney (2005) of firms heterogeneous in productivity levels facing fixed costs of exporting by modeling external financing in addition to internal financing. More importantly, the main difference between my model and related models (Chaney 2005, Muûls 2008, and Suwantaradon 2008) is that I model explicitly the firm's borrowing decision and the bank's lending decision under imperfect information as well as

[1] A more detailed list of the various reasons why exporting requires additional external financing compared to domestic sales can be found in Manova (2013).

endogenous bankruptcy.[2] My model predicts that a firm's credit constraint has a negative impact on its export propensity, especially if the firm is in the intermediate productivity range. Compared to exogenous credit constraint models, this model allows for the presence of a less clear cut of selection into exports based on productivity. While in Melitz (2003), Chaney (2005) and Manova (2014), there is a clear selection into exporting within the economy or within a sector entirely based on firm productivity levels, endogenous credit constraint allows for a more realistic case where while on average, exporters are more productive than domestic producers, there are cases where exporters are less productive than domestic producers but have more financial resources to bear the costs of exporting.

In my empirical estimation, I use a credit constraint indicator that include both access to bank overdraft facilities and an indicator of bank loan constraint. To the best of my knowledge, the role of access to overdraft facilities have not been studied much in the literature. In addition, my measure of bank loan constraint utilizes the information from the survey data that allows me to distinguish discouraged borrowers, i.e. firms that have needs for external financing but are discouraged from applying for loans because of various reasons. My empirical results support the model's predictions. Having access to credit is found to increase a firm's likelihood to export. Furthermore, the empirical results also confirm the heterogeneous effect of access to credit: the positive effect of access to credit on export likelihood is only present for firms in the intermediate range of productivity.

II. Model

The model in this paper is an extension of Melitz (2003) featuring constant elasticity of substitution (C.E.S) preference and firms that are heterogeneous in productivity. However, in my model, firms are also heterogeneous in two other dimensions: the amount of liquidity and collateral. Thus, while the segmentation of firms into non-producer, domestic producers, and exporters in Melitz's model is only based on productivity, the segmentation of firms in my model is not only based on productivity but also on firm's liquidity and collateral. In addition, I also introduce an exogenous income shock to exporters, which can be caused by a shock to the demand for the exported variety, a feature that is borrowed from Garcia-Vega et al. (2012).[3] This shock allows me to achieve a more realistic equilibrium where there are some bankruptcy cases.

1. Consumers (Demand)

There are two symmetric countries. In each country, the intertemporal utility function of a representative consumer is:

[2] Chaney (2005) does not model external financing. In Manova (2008) and Muûls (2008), firms are assumed to default at an exogenous rate λ_j that only varies across countries. My model allows for a more realistic assumption, where the firm's default probability depends on its productivity and net worth and thus, allows for different default probabilities across firms with different characteristics. Suwantaradon (2008) does not model firm's default on debts. She also assumes that every firm can borrow at the risk-free interest rate and thus, does not model firm's financial constraints in terms of the differential interest rates they face when borrowing.

[3] Garcia-Vega et al. (2012) assume that the standard deviation of the shocks varies across firms and such, represent firm's income volatility. On the other hand, my model assumes that firm's income shock is a random draw from a common normal distribution, i.e. the standard deviation of firm's income shock is the same for every firm.

$$U_t = \int_0^{\infty} (x_{0t} + \log Y_t) e^{-\beta t} dt$$

where β is the discount factor, x_0 is the consumption of a numeraire good, and Y_t is an index of consumption of the differentiated products that reflects consumers' taste for varieties in period *t*.

$$Y_t = \left[\int_0^{M_t} y_{z,t}^{\rho} dz \right]^{1/\rho}$$

with $0 < \rho < 1$, $y_{z,t}$ is the quantity of variety *z* of the differentiated product demanded by consumers in period *t*, M_t is the mass of firms in the stationary competitive equilibrium, and $\mu = 1/(1-\rho)$ is the elasticity of substitution among varieties.
The aggregate price index for the differentiated product is a weighted price index of the prices of each individual variety $p_{z,t}$:

$$P_{Y,t} = \left[\int_0^{M_t} p_{z,t}^{1-\mu} dz \right]^{1/(1-\mu)}$$

The aggregate expenditure, R_t, is normalized to one, and the demand for variety *z* in period *t* can be expressed as follows:

$$y_{z,t} = \frac{p_{z,t}^{-\mu}}{P_{Y,t}^{1-\mu}} \qquad (1)$$

2. Firms

In terms of notation, the superscripts *D* and *X* refers to the domestic market and the foreign market respectively. For simplification of notation, I omit the firm and time subscripts (*i* and *t*) in this section.

2.1. Firm production

In each country (home or foreign), there is a continuum of firms. There are three sources of heterogeneity among firms: (1) their level of productivity φ, (2) exogenous liquidity endowment n, and (3) collateral value A, $\varphi, n, A \in R^+$. I assume φ, n and A are independently distributed with joint distribution $F(\varphi,n,A)$ and density $f(\varphi,n,A) = f(\varphi)g(n)k(A)$ where $f(\varphi)$, $g(n)$ and $k(A)$ are density functions for productivity, liquidity endowment, and collateral respectively, and $F(\varphi)$, $G(n)$ and $K(A)$ are the respective cumulative distribution functions, hereafter referred to as *c.d.f.* All these distributions are known to both firms and banks.

Both domestic and exporting firms are hit by exogenous death shocks with probability *p* every period. Domestic production faces no income shocks. In each period *t*, if firm *i* decides to export, it will face an export income shock z_{it}. The income shock follows a normal distribution $N(1, \sigma^2)$ which is left-truncated at zero and is common knowledge. The export income shock can be thought of as a shock to the price of the exported goods caused by a reduction in foreign demand for those goods. When the firm makes its export decision in period *t*, it knows its productivity shock for that period but it does not know the export income shock for that period yet. To operate, potential entrants have to pay a sunk entry cost f^{e} to start operation. If a firm wants to enter the export market, it has to pay a sunk entry costs in exporting f^{ex} to start exporting.

The firm production function is as follows:

$$l^{D}(\varphi) = \omega f^{D} + \frac{y^{D}(\varphi)}{\varphi}$$

$$l^{X}(\varphi) = \omega f^{X} + \frac{y^{X}(\varphi)}{\varphi}$$

where l is labor, y is output and ωf is the fixed costs of production. A firm's productivity φ is simply the inverse of its marginal costs. Thus, to produce the same amount of output (y), a more productive firm will need less labor than a less productive one.

Exporting is subject to iceberg transportation costs. For each τ units of the goods that are shipped abroad, only 1 unit arrives. Profit maximization leads to the following pricing rules that equate marginal revenue and marginal cost in the domestic and in the foreign markets:

$$p^{D}(\varphi) = \frac{\omega}{\rho\varphi}$$

$$p^{X}(\varphi) = \frac{\tau\omega}{\rho\varphi}$$

where ω is the common real wage rate in the home country. The optimal pricing rule implies that more productive firms charge a lower price both domestically and abroad since they have lower marginal costs.

Revenue from selling in domestic market and from exporting for a firm with productivity φ is:

$$r^{D} = R(P\rho\varphi)^{\mu-1} = (P\rho\varphi)^{\mu-1}$$

$$r^{X} = \tau^{1-\mu} r^{D}$$

Since $\mu > 1$, both revenue from domestic sales and from exporting are increasing in firms' productivity levels. Intuitively, more productive firms sell more, charge lower prices, and generate more revenues.

2.2. Firms' Decisions

Firms can borrow at zero interest rate to cover the fixed costs of production for the domestic market (ωf^{D}). However, if they want to export and their liquidity is lower than ωf^{X}, they face a cash-in-advance constraint for exporting in each period. If these firms decide to export, they have to borrow from banks a loan equal to the fixed costs of exporting (ωf^{X}) at an interest rate r

where $r > r_0$, the interest rate on riskless assets.[4] To make the analysis simple, I assume that the liquidity of a firm is fixed, i.e. firms cannot add their profits to the stock of liquidity but just distribute all the profits as dividend payments. At the end of the period, if paying back the loan makes the firm's net worth negative, the firm defaults, exits, and the bank gets the firm's net worth and collateral at that time. Otherwise, the firm will pay back the original loan amount plus interest.

Profits from selling in the domestic market, hereafter called domestic profits, are:[5]

$$\pi^D = p^D(\varphi)y^D(\varphi,\overline{\varphi}^D) - \frac{\omega * y^D(\varphi,\overline{\varphi}^D)}{\varphi} - \omega f^D = \frac{r^D(\varphi,\overline{\varphi}^D)}{\mu} - \omega f^D \tag{2}$$

where $\mu = 1/(1-\rho)$, $r^D(\varphi,\overline{\varphi}^D)$ is domestic revenue, and $\overline{\varphi}^D$ is the productivity cutoff that solves $\pi^D = 0$. It can easily be seen that domestic profit is increasing in productivity. This implies that every firm that has a productivity draw less than the cutoff $\overline{\varphi}^D$ will exit the market immediately while every firm with productivity above this cutoff will produce.

Let $\overline{\varphi}^{X,NB}$ be the productivity cutoff at which an exporter's expected profits equals zero:

$$\begin{aligned} E(\pi^{X,NB}) &= p^X(\varphi,\tau)y^X(\varphi,\overline{\varphi}^X) - \frac{\omega\tau * y^X(\varphi,\overline{\varphi}^X)}{\varphi} - (1+r_0)\omega f^X \\ &= \frac{r^X(\varphi,\overline{\varphi}^{X,NB})}{\mu} - (1+r_0)\omega f^X = 0 \end{aligned} \tag{3}$$

where E is the expectation operator.[6] Following common practice in the international trade literature, I assume the fixed costs and iceberg transportation costs are such that $\overline{\varphi}^D < \overline{\varphi}^{X,NB}$.[7] Under this assumption, firms with $\overline{\varphi}^D \le \varphi < \overline{\varphi}^{X,NB}$ will produce only for domestic market regardless of the level of their liquidity n and collateral A. These are unconstrained domestic producers because they would not export even if the loan for export has zero interest rate.

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[4] Since lending to exporting firms involve a risk that some firms may default, the interest rate that banks charge on these loans are higher than the interest rate on riskless assets.

[5] The firm's income from domestic production is:

$$I^D = p^D(\varphi)y^D(\varphi,\overline{\varphi}^D) - \frac{\omega * y^D(\varphi,\overline{\varphi}^D)}{\varphi} - \omega f^D + (1+r_0)n = \frac{r^D(\varphi,\overline{\varphi}^D)}{\mu} - \omega f^D + (1+r_0)n$$

However, firm profit, in this paper, is the extra income the firm earns compared to its outside opportunity of not operating, $(1+r_0)n$.

[6] Again, this cutoff is deduced by equating the firm's expected income for non-borrowing exporting with its outside opportunity of producing for only the domestic market.

[7] Specifically, as shown in Melitz (2003), $\overline{\varphi}^{X,NB} > \overline{\varphi}^D$ if and only if $\tau^{\mu-1}\omega f^x > \omega f^D$

Firms with $n \geq \omega f^{X}$ and $\varphi \geq \overline{\varphi}^{X,NB}$ will find it profitable to use their own liquidity to finance fixed costs of export.[8] They also earn the riskless interest rate on the remaining liquidity after paying for the fixed costs of exports. Thus, their income in period *t* is:

$$I^{X,NB} = \pi^{D} + z_{it} p^{X}(\varphi,\tau) y^{X}(\varphi,\overline{\varphi}^{X}) - \frac{\omega\tau * y^{X}(\varphi,\overline{\varphi}^{X})}{\varphi} + (1+r_0)(n-\omega f^{X}) \quad (4)$$

The probability that a non-borrowing exporter does not survive the export income shock is:

$$\Phi^{X,NB} = \text{Probability}\left[\pi^{D} + z_{it} p^{X}(\varphi,\tau) y^{X}(\varphi,\overline{\varphi}^{X}) - \frac{\omega\tau * y^{X}(\varphi,\overline{\varphi}^{X})}{\varphi} + (1+r_0)(n-\omega f^{X}) < 0\right]$$
$$= \text{Probability}\left[z_{it} < \frac{\omega\tau * y^{X}(\varphi,\overline{\varphi}^{X})/\varphi - (1+r_0)(n-\omega f^{X}) - \pi^{D}}{p^{X}(\varphi,\tau) y^{X}(\varphi,\overline{\varphi}^{X})}\right]$$
$$= \Phi\left[\frac{\omega\tau * y^{X}(\varphi,\overline{\varphi}^{X})/\varphi - (1+r_0)(n-\omega f^{X}) - \pi^{D} - 1}{\sigma p^{X}(\varphi,\tau) y^{X}(\varphi,\overline{\varphi}^{X})}\right] \quad (5)$$

where Φ is the *c.d.f* of the standard normal distribution that is left truncated at $-1/\sigma$.[9]

Next, I solve for the export decision for firms with $n < \omega f^{X}$. Suppose that the bank offers firms a fixed loan amount equal to ωf^{X} at interest rates that differ across the firms, depending on the bank's evaluation of the firm's probability of defaulting on loan. In period *t*, for firm *i* that gets a loan from the bank at an interest rate r_{it}, the probability of default is:

[8] The costs of using firm's own liquidity to cover fixed costs is the forgone interest earned at the riskless interest rate r_0 while the costs of borrowing from banks are the interest payments at the loan interest rate $r > r_0$. Therefore, given that it has enough liquidity to cover fixed costs, a firm will always prefer using its own liquidity to borrowing from the bank. This assumption is based on the "pecking order" theory which claims that because of asymmetric information, new equity-holders and new debt-holders do not have as much information about the firm as the firm itself. To account for these uncertainties, these people will expect a higher rate of return on their investments than the opportunity cost of internal funding. Thus, firms will prefer internal funding than external financing.

[9] This is because z_{it} follows a truncated normal distribution $N(1,\sigma^2)$, left truncated at zero.

$$
\begin{aligned}
&\Phi(\varphi_{it}, \overline{\varphi}^{D}, \overline{\varphi}^{X,B}, r_{it}, n_{it}) \\
&= P\left(\pi^{D}(\varphi, \overline{\varphi}^{D}) + z_{it} p^{X}(\varphi, \tau) y^{X}(\varphi, \overline{\varphi}^{X}) - \frac{\omega\tau * y^{X}(\varphi, \overline{\varphi}^{X,B})}{\varphi} - (1+r)\omega f^{X} + (1+r_0)n \le 0 \right) \\
&= P\left(z_{it} \le \frac{(1+r)\omega f^{X} - (1+r_0)n + (\omega\tau * y^{X} / \varphi) - \pi^{D}}{p^{X} y^{X}} \right) \qquad (7) \\
&= \Phi\left(\frac{(1+r)\omega f^{X} - (1+r_0)n + (\omega\tau * y^{X} / \varphi) - \pi^{D} - 1}{p^{X} y^{X} \sigma} \right) \\
&\equiv \Phi^{X,B}
\end{aligned}
$$

where Φ denotes the *c.d.f* of a standard normal distribution left-truncated at $-1/\sigma$. It can be shown that the probability of default is decreasing in firm liquidity and under certain conditions, decreasing in firm productivity.[10]

Firms with $n < \omega f^{X}$ will decide to export in period *t* if the expected discounted profit from borrowing to export, $V^{X,B}$, is greater than or equal to the expected discounted profit from producing domestically, V^{D}. Since the liquidity endowment, productivity and market structure do not change over time, a firm that decides to borrow to export in period *t* will still decide to borrow to export in the following periods given that it survives the exogenous death shock and has not defaulted on a loan. Similarly, a firm that decides to produce only domestically in period *t* will continue to produce only for the domestic market in the following periods given that it has survived the exogenous death shock in previous periods.

Let β be the discount rate. A firm's expected value at time *t* of borrowing to export ($V_t^{X,B}$) and of producing only for domestic market (V_t^{D}) can be written as:

$$
V_t^{X,B}(n, \varphi, r_{it}) = \frac{1}{1 - \beta(1-p)(1-\Phi^{X,B})} \left[\pi^{D} + p^{X} y^{X} - \frac{\omega\tau * y^{X}}{\varphi} - (1+r_{it})\omega f^{X} + (1+r_0)n \right] - f^{ex}
$$

$$
V_t^{D}(n, \varphi) = \frac{1}{1-\beta(1-p)} \left[\pi^{D} + (1+r_0)n \right]
$$

where

$$
\pi^{D} = p^{D}(\varphi) y^{D}(\varphi, \overline{\varphi}^{D}) - \frac{\omega * y^{D}(\varphi, \overline{\varphi}^{D})}{\varphi} - \omega f^{D}
$$

It can be shown that when $\Phi < \frac{[1-\beta(1-p)]\tau^{1-\mu}}{\beta(1-p)}$, productivity is positively related to export propensity (see *Appendix C*). Specifically, among firms with $\varphi \ge \overline{\varphi}^{X,NB}$ and $n < \omega f^{X}$, the more productive the firm is, the more likely it will borrow to export. It can also be shown that when $\frac{\Phi}{\phi} < \frac{\{\pi^{D} + (1+r_0)n\}}{p^{X} y^{X} \sigma}$ with ϕ being the p.d.f of the truncated normal standard distribution which

[10] See *Appendix C* for the proof.

is left-truncated at $-1/\sigma$, a firm with higher liquidity level will more likely borrow to export.[11] This is because a firm with more liquidity can use its liquidity stock to pay back the loans when hit by a negative export shock and thus, is more likely to avoid bankruptcy if it borrows to export.

It can be proved that $\overline{\varphi}^{D} < \overline{\varphi}^{X,NB} < \overline{\varphi}^{X,B}(r_{it})$ for any positive loan interest rate r_{it} and thus, the model implies that all exporters also produce for the domestic market.[12]

3. Bank's Lending Decisions

I assume a competitive banking industry in which banks make zero profits. A representative bank offers a fixed loan amount, ωf^{X}. The bank observes the firm's liquidity level and collateral but does not observe the firm's productivity. However, the bank forms an evaluation of this productivity as a function of the firm's characteristics:

$$\varphi^{B} = f(Z)$$

where Z is a vector of firm characteristics. Based on this evaluation, the bank expects the probability of default for the firm to be $\Phi^{X,B}(\varphi^{B}, n)$. To keep the model general, I do not specify the elements of *Z* in the model but in the empirical section, I will estimate the determinants of access to credit.

For firm *i* in period *t*, let $z_{it}^{B,Default}$ be the cutoff export income shock such that a shock less than $z_{it}^{B,Default}$ will cause a borrowing exporter with productivity φ^{B} and liquidity *n* to go bankrupt. Then $z_{it}^{B,Default}$ solves:

$$I^{X,B}(z_{it}, \varphi^{B}, n) = \pi^{D} + z_{it} p^{X} y^{X} - \frac{\omega\tau * y^{X}}{\mu} + (1+r_{0})n - (1+r_{it})\omega f^{X} = 0 \quad (8)$$

Let $z_{it}^{B,Min}$ be the lowest export income shock below which the firm's net worth becomes negative. Then $z_{it}^{B,Min}$ solves:

$$I^{X,B}(z_{it}, \varphi^{B}, n) = \pi^{D} + z_{it} p^{X} y^{X} - \frac{\omega\tau * y^{X}}{\mu} + (1+r_{0})n = 0 \quad (9)$$

Let $E_{t}\left[I^{X,B}(\varphi^{B}, n) \middle| default\right]$ be the bank's expectation of the firm's net worth (excluding collateral) in the next period if the firm suffers from a bad export income shock and has to default. This expectation is based on the bank's prediction of firm's productivity φ^{B} and the

[11] Detailed proof can be found in *Appendix C*.

[12] One objection can be that in reality, we may have a corner solution where some firms serve only the foreign market. However, in the empirical estimation, I analyze a panel data of Ghanaian manufacturing firms that has only 2% of the firms serving only foreign markets without serving the domestic market. Therefore, I consider the implication of the model that all exporters also serve domestic market to be reasonable.

firm's liquidity stock *n*. Note that the firm's liquidity is observable to the bank but the firm's productivity is not.

$$E_t\left[I^{X,B}(\varphi^B,n)\middle|default\right]=\int_{z_{it}^{B,Min}}^{z_{it}^{B,Default}}\left[\pi^D+z_{it}p^X y^X-\frac{\omega\tau * y^X}{\mu}+(1+r_0)n\right]l(z)dz$$

where $l(z)$ is the density function of the export income shock assumed as above to follow a truncated normal distribution $N(1,\sigma^2)$ left-truncated at zero.

For firm *i* that comes to borrow for export in period *t*, the bank will choose a loan interest rate r_{it} such that its expected return from lending equals the expected returns if the firm had invested in riskless assets:

$$(1+r_0)\omega f^X = \left[1-\Phi^{X,B}(\varphi^B,n)\right](1+r_{it})\omega f^X+\Phi^{X,B}(\varphi^B,n)\left\{E_t\left[I^{X,B}(\varphi^B,n)\middle|default\right]+A_{it}\right\} \quad (10)$$

The left-hand-side (LHS) of the equation above is the return on riskless assets. The right-hand-side (RHS) consists of the expected repayments to the bank if the firm does not default (the first term on the RHS) and the expected collection the banks can make if the firm defaults (the second term on the RHS). $E_t\left[I^{X,B}(\varphi^B,n)\middle|default\right]$ is increasing in the (bank's evaluation of) firm productivity level and liquidity level.[13] As shown earlier, $\Phi^{X,B}(\varphi^B,n)$ is decreasing in both the firm's liquidity level and the bank's evaluation of the firm's unobserved productivity. Therefore, it is obvious from the equation above that the bank's loan interest rate to the firm is decreasing in the firm's collateral value, in the firm's liquidity level, and in the bank's evaluation of the firm's unobserved productivity.

As a summary, the segmentation of firms predicted by the model can be summarized in Figure 2.1, which is drawn holding collateral fixed. The graph holding liquidity fixed would be similar. Firms that have productivity less than the cutoff $\overline{\varphi}^D$ do not operate at all (regardless of their liquidity and collateral) since they are not profitable. For firms that have sufficient liquidity (*n*) to finance the fixed costs of exporting, the productivity cutoff for exporting does not depend on liquidity *n* or collateral *A*. For these firms, the decision to export depends only on productivity and not on financial factors or collateral capability. For firms with insufficient liquidity, i.e., firms with $n<\omega f^X$, the productivity cutoff for exporting depends on both the firm's liquidity and collateral. Specifically, this cutoff is lower for firms with higher liquidity and/or collateral. In other words, for firms with insufficient liquidity, the importance of productivity on export decision is reduced as the export decision also depends on financial factors and collateral capability. The segmentation just described can be summarized in *Figure 1*. To achieve analytical equilibrium solutions, I will assume that on average, the bank's expectation of the probability that a firm defaults is correct, i.e. equal to the actual probability of default.

4. Aggregation

Denote *M* as the mass of firms in the equilibrium. Let M^D be the number of firms in the home country that produce domestically only. Let $M^{X,B}$ be the number of borrowing exporters

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[13] See proofs in *Appendix C*.

and $M^{X,NB}$ be the number of non-borrowing exporters. As in the Melitz (2003) model, in equilibrium, the weighted average productivity of all firms in the home country (including both domestic and foreign firms) with the weight being the relative shares of firm outputs is:

$$\tilde{\varphi} = \left\{ \frac{1}{M} [M^D (\tilde{\varphi}^D)^{\mu-1} + M^{X,B} (\tau^{-1} \tilde{\varphi}^{X,B})^{\mu-1} + M^{X,NB} (\tau^{-1} \tilde{\varphi}^{X,NB})^{\mu-1}] \right\}^{\frac{1}{\mu-1}} \tag{11}$$

Aggregate variables can be expressed as a function of this average productivity:

$$P = M^{1/(1-\mu)} \frac{1}{\rho \tilde{\varphi}} \tag{12}$$

$$Q = M^{1/\rho} q(\tilde{\varphi})$$

The equilibrium is characterized by two equilibrium conditions: the zero cutoff profit conditions (ZCP) and the free entry condition (FE). The ZCP condition in the domestic market solves for the productivity of the "marginal" firm in the domestic market whose profits from domestic sales are exactly zero. Since profits are increasing in productivity levels, all firms with productivity below this cutoff will not produce at all and all firms with productivity above this cutoff will produce. Similarly, the ZCP condition for exporting solves for the export productivity cutoff where only firms with productivity equal or above this cutoff will export. Finally, the free-entry condition ensures that *ex-ante* expected profits from entering the market is driven down to zero since as long as expected profit is positive, more firms will enter which increases competition and drives the expected profits down until it comes to zero at which point a potential entrant is indifferent about entering the market. [14]

$$\pi^D (\overline{\varphi}^D) = 0$$
$$\pi^{X,B} \left[\overline{\varphi}^{X,B} (n, A) \right] = 0$$
$$\pi^{X,NB} (\overline{\varphi}^{X,NB}) = 0$$

Let $\gamma^D(\varphi)$ be the equilibrium distribution of productivity levels for incumbent firms, i.e. firms that are productive enough to stay in the market, then $\gamma^D(\varphi)$ is the conditional distribution of $f(\varphi)$ on $[\overline{\varphi}^D, \infty)$:

$$\gamma^D(\varphi) = \begin{cases} \dfrac{f(\varphi)}{1 - F(\overline{\varphi}^D)} & \text{if } \varphi \geq \overline{\varphi}^D \\ 0 & \text{otherwise} \end{cases}$$

[14] In the *Firm's Decision* section, we can see that $\overline{\varphi}^{X,B}$ is a function of the bank's loan interest rate, r_{it}. On the other hand, by assumption, r_{it} is a function of firm collateral, liquidity and the bank's evaluation of the firm unobserved productivity. Given our assumption that the expected value of the bank's valuation of firm productivity is equal to the firm's real productivity, $\overline{\varphi}^{X,B}$ is a function of n and A_{it} only.

Similarly, $\gamma^{X,NB}(\varphi) = \frac{f(\varphi)}{1 - F(\overline{\varphi}^{X,NB})}$ is the equilibrium distribution of productivity levels for non-borrowing exporters, and $\gamma^{X,B}(\varphi) = \frac{f(\varphi)}{1 - F\left[\overline{\varphi}^{X,B}(n,A)\right]}$ is the equilibrium distribution of productivity levels for borrowing exporters.

$$\gamma^{X,NB}(\varphi) = \begin{cases} \dfrac{f(\varphi)}{[1 - F(\overline{\varphi}^{X,NB})][1 - G(\omega f^{X})]} & \text{if } \varphi \geq \overline{\varphi}^{D} \text{ and } n \geq \omega f^{X} \\ 0 & \text{otherwise} \end{cases}$$

$$\gamma^{X,B}(\varphi, n, A) = \begin{cases} \dfrac{f(\varphi)}{[1 - F(\overline{\varphi}^{X,B}(n,A))]G(\omega f^{X})} & \text{if } \varphi \geq \overline{\varphi}^{D} \text{ and } n < \omega f^{X} \\ 0 & \text{otherwise} \end{cases}$$

Using these conditional distributions, we can rewrite the three aggregate average productivities in terms of the corresponding productivity cutoffs as follows:[15]

$$\tilde{\varphi}^{D} = \left[\int_{\overline{\varphi}^{D}}^{\infty} \varphi^{\mu-1} \gamma^{D}(\varphi) d\varphi\right]^{\frac{1}{\mu-1}}$$

$$\tilde{\varphi}^{X,NB} = \left[\int_{n=\omega f^{X}}^{\infty} \int_{\overline{\varphi}^{X,NB}}^{\infty} \varphi^{\mu-1} \gamma^{X,NB}(\varphi) d\varphi\right]^{\frac{1}{\mu-1}}$$

$$\tilde{\varphi}^{X,B} = \int_{A=0}^{A=\infty} \int_{n=0}^{n=\omega f^{X}} \left[\int_{\overline{\varphi}^{X,B}}^{\infty} \varphi^{\mu-1} \gamma^{X,B}(\varphi, n, A) d\varphi\right]^{\frac{1}{\mu-1}} g(n) k(A) dn dA$$

Thus, the zero-profit conditions can be written as:[16]

$$\pi^{D}(\tilde{\varphi}) = \omega f^{D} q(\overline{\varphi}^{D}, \tilde{\varphi})$$

$$\pi^{X,NB}(\tilde{\varphi}) = \omega f^{X} q(\overline{\varphi}^{X,NB}, \tilde{\varphi})$$

$$\pi^{X,B}(\tilde{\varphi}) = \omega f^{X} h(\overline{\varphi}^{X,B}, \tilde{\varphi})$$

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[15] Note that the segmentation of firms into non-borrowing exporters and borrowing exporters not only depends on firm productivity but also depends on firm liquidity level. However, because I have assumed the distributions of liquidity and productivity are independent of one another, I can define the aggregate average productivity for domestic producers and for non-borrowing exporters independently of the liquidity level.

[16] Since $(1+r)n$ is the deposit and interest earnings on firm liquidity that the firm would earn regardless of whether it produces or not, firm profit should be considered against this opportunity cost. Therefore, a firm profit is defined as its revenue from selling products net its labor costs and fixed costs and net the loan payments (loan amount plus interests) if the firm borrows to export. With this definition of profit, all of the aggregate profits can be written as functions of productivity cutoffs and fixed costs of production.

where $q(\overline{\varphi}^{D},\widetilde{\varphi})=[\widetilde{\varphi}/\overline{\varphi}^{D}]^{\mu-1}-1$, $q(\overline{\varphi}^{X,NB},\widetilde{\varphi})=[\widetilde{\varphi}/\overline{\varphi}^{X,NB}]^{\mu-1}-1$, and
$h(\overline{\varphi}^{X,B},\widetilde{\varphi})=\int_{A=0}^{A=\infty}\int_{n=0}^{n=\omega f^{X}}\{[\widetilde{\varphi}/\overline{\varphi}^{X,B}(n,A)]^{\mu-1}-[1+r(\widetilde{\varphi},n,A)]\}g(n)k(A)dndA$

This implies that average aggregate profit can be expressed as:

$$\overline{\pi}=\pi^{D}(\widetilde{\varphi}^{D})+p^{X,NB}\pi^{X}(\widetilde{\varphi}^{X,NB})+p^{X,B}\pi^{X}(\widetilde{\varphi}^{X,B}) \qquad \text{(ZCP)}$$

$$=\omega f^{D}k(\overline{\varphi}^{D},\widetilde{\varphi})+p^{X,NB}\omega f^{X}k(\overline{\varphi}^{X,NB},\widetilde{\varphi})+p^{X,B}\omega f^{X}h(\overline{\varphi}^{X,B},\widetilde{\varphi})$$

where $p^{X,NB}$ and $p^{X,B}$ are the *ex-ante* probability that an operating firm will export without borrowing, and the *ex-ante* probability that an operating firm will borrow to export, respectively. These probabilities are calculated as follows:

$$p^{X,NB}=\frac{[1-F(\overline{\varphi}^{X,NB})][1-G(\omega f^{X})]}{1-F(\overline{\varphi}^{D})}$$

$$p^{X,B}=\frac{G(\omega f^{X})}{1-F(\overline{\varphi}^{D})}\int_{A=0}^{A=\infty}\int_{n=0}^{\omega f^{X}}[1-F[\overline{\varphi}^{X,B}(n,A)]]g(n)k(A)dndA$$

where F and G are defined above as the cumulative distribution functions of productivity and liquidity. The *ex-ante* probability an entrant is a non-borrowing exporter ($p^{X,NB}$) is the probability that an entrant picks both a draw of productivity that is greater or equal to the cutoff for non-borrowing exporting and a draw of liquidity that is greater than the fixed costs of exporting, conditional on having a productivity draw that is greater than the productivity cutoff for operating ($\overline{\varphi}^{D}$). Similarly, the probability an entrant is a borrowing exporter ($p^{X,B}$) is the probability that conditional on drawing a productivity level greater than the productivity cutoff for operating ($\overline{\varphi}^{D}$), an entrant draws a liquidity that is less than the fixed costs of exporting and has a combination of liquidity and collateral such that it is profitable to borrow to export.
The *ex-ante* probability that one of the surviving firms will export is:

$$p^{X}=p^{X,NB}+p^{X,B}$$

Let υ_{e} denote the *ex-ante* net value of entry and $\overline{\upsilon}$ denote the average present value of operating firms. Free entry implies that potential entrants will enter the market as long as the expected net value of entry is positive. Therefore, in equilibrium, the *ex-ante* net value of entry is zero, hence called the free entry condition.

$$\upsilon_{e}=\text{Probability(firms get a productivity draw high enough to stay in the market)}*\overline{\upsilon}-f^{e}=0$$

or $\upsilon_{e}=[1-F(\overline{\varphi}^{D})]*\overline{\upsilon}-f^{e}=0$

where $\bar{\upsilon} = \sum_{t=0}^{\infty} [\beta(1-p)]^t \bar{\pi} = \dfrac{\bar{\pi}}{1-\beta(1-p)}$, β is the discount rate, f^e is the fixed cost of entry which is sunk thereafter, and p is the probability firms will be hit by a death shock in each period. Thus, the free-entry condition can be rewritten as:

$$\bar{\pi} = \frac{[1-\beta(1-p)]f^e}{1-F(\bar{\varphi}^D)} \qquad \text{(FE)}$$

The (ZCP) and (FE) conditions determine the productivity cutoffs. The mass of firms in equilibrium can be determined as:

$$M = \frac{R}{r(\tilde{\varphi})} = \frac{\omega L}{r(\tilde{\varphi})}$$

where L is the country's population. The mass of export firms is $p^X M$.

The model yields two predictions. The first prediction implies that access to finance, on average, increases firms' export propensity. For the group of firms that does not have enough internal funds to cover the fixed costs of exporting but is productive enough to be profitable from exporting, only some firms - those that have access to bank financing - can export. This implies that access to bank financing should have a positive effect on firms' export status.

The second prediction is that the effect of access to credit on firms' export propensity is heterogeneous: access to credit has the most positive effect on export propensity for firms that are in the intermediate range of productivity. For firms that have very low productivity levels, i.e., less than $\bar{\varphi}^{X,NB}$, whether the firms have access to financing does not affect their export decisions. The model implies that the cutoff productivity for exporting for borrowing firms ($\bar{\varphi}^{X,B}$) is decreasing in productivity, illustrated in Figure 1 by the downward-sloping curve of $\bar{\varphi}^{X,B}$. This means that very productive firms are much more likely to be profitable from exporting even when they have to borrow. For these reasons, access to credit does not have much effect on the export decisions of the least and most productive firms, but has most impact on the export decision of firms that are in the intermediate range of productivity. Intuitively, the most productive firms can generate enough internal funds from their domestic sales to cover most of the costs of exporting, so external financing is not as important for their export decision. The least productive firms would not export even when there is no credit constraint since these firms are not productive enough to be profitable from exporting. Therefore, the group that is potentially most affected by having access to external financing would be firms in the intermediate range of productivity. These firms have the potential to gain profits from exporting, but need external financing to export since they are not productive enough to generate sufficient internal funds to finance exporting. In the empirical estimation, I will test the two hypotheses above.

III. Empirical Testing

1. Credit Constraints in Ghana

Ghana is a country in West Africa with a population in 2014 of about 25 million. The period 1991-1997 was one of moderate growth rates for Ghana, with GDP growth averaging 4.3%. Manufacturing was the second largest sector, contributing on average 10.1% of total value added (International Financial Statistics). During the period 1983-1989, Ghana went through significant trade liberalization and economic restructuring guided by an Economic Recovery Program (ERP) under the IMF and the World Bank (1983-1986), and a Structural Adjustment Program (SAP) starting in 1989. By the end of 1989, Ghana had a liberalized trade regime. The SAP also included the Financial Sector Reform Program (FINSAP), the first phase of which was implemented during 1989-1990. The FINSAP restructured distressed banks with government taking over non-performing loans, eliminated government's control over loan interest rates, reduced state shareholdings in Ghanaian banks, and implemented changes in policy relating to credit allocation (Aryeetey et al. 1994). In the year 1994, the second phase of FINSAP was implemented with the major objective of privatizing the state-owned banks and developing non-bank financial institutions to fill gaps in the financial markets not served by the banks. By the end of 1994, Ghana had thirteen commercial, savings, development and merchant banks, together with rural banks that mainly served smaller loan demand.[17] However, financial reforms had not left much impact. The Ghana Stock Exchange (GSE) came into operation in 1990 and the GSE remains an unimportant source of funds for Ghanaian firms. In 1997, only 21 firms were listed in the GSE.

With trade liberalization, one expects to see an increase in Ghanaian exports and in the productivity of Ghanaian exporters as predicted by Melitz (2003)'s model and other following studies. However, as my model also implies, productivity may not be the only factor that affects export participation. Financial constraints may hinder productive but small firms from exporting. Given that trade barriers were reduced significantly but the impact of financial reforms in Ghana was still limited for the period 1991-1997, analyzing the Ghanaian data set for this period will highlight the importance of access to financing in firms' export participation.

Empirical application of the paper's model requires a data set that satisfies the following criteria: (1) the data set comes from a country where firms face financial constraints, (2) bank credit is an important source of financing for firms, (3) banks make lending decisions based on firm characteristics such as age, collateral, and evaluation of firm productivity, and (4) significant heterogeneity among firms in terms of productivity or profitability is observed. The first two criteria ensure that the ability to obtain bank credits is critical for financially constrained firms to overcome their constraints. The last two criteria ensure that the data fit well with the model's assumptions. The Ghanaian firm data set used in this paper is suitable since it satisfies these four criteria as explained below.

First, there is empirical evidence that firms in Ghana do face substantial credit constraints. In Ghana, an uncompetitive financial market structure, lack of a central credit information system, lack of cooperation among banks in sharing customer information, and weak enforcement of creditors' rights result in severe credit constraint. Lending remained constrained despite excess demand for credit – particularly by small-scale enterprises with good opportunities but

[17] Commercial banks offer traditional banking services, with a focus on universal retail services. Merchant banks are fee-based and focus mostly on corporate banking services. Development banks specialize in medium and long-term finance.

insufficient collateral Aryeetey et al. (1997). Steel and Webster (1992) comment that for small firms that adapted to changes under the ERP successfully, the most critical constraint was lack of access to finance for working capital and new investment. In addition, most deposits into banks in Ghana are of a short-term nature and "the enforcement of creditors' rights is weak compared with the sub-Saharan African average" (Buchs and Mathisen 2005).[18] Because of these limitations, lenders favor overdrafts and short- to medium-term bank loans to force borrowing firms to account regularly for their actions Fafchamps et al. (1994).[19]

As for the second criterion that bank credit is the primary source of external financing for firms, Bigsten et al. (2003) find that although informal credit market is viable in Ghana, it is relatively unimportant for the manufacturing sector. This suggests that using barriers to bank loan and access to bank overdraft facilities to proxy for financial constraint for manufacturing firms, as is done in the empirical section of the paper, is appropriate for this data set.

The third criterion requires that in practice, banks do base on a firm's liquidity measures such as cash flows, proxies for productivity, and collateral in determining the firm's ability to pay back the loan. While there has not been empirical study of the correlation between a firm's liquidity amount and its chance of obtaining loans from banks in Ghana, a number of studies have pointed out that banks' lending decisions are based on signals of productivity, such as age or expected profitability (Bigsten et al. 2003, Abor 2008), and collateral (Bigsten et al. 2003, Storey 1994, Berger and Udell 1998, and Abor 2008).

As for the fourth criterion, there is also evidence that Ghanaian firms differ in their productivity. For example, Steel and Webster (1992) observe that following the ERP program, there are two groups among small firms: the successful adapters with good prospects and stagnant producers who had not adapted to the new competitive environment. In addition, while manufacturing grew at a slow rate (2.6 percent) during the period of 1990-1996, the share of manufacturing in Ghana's total exports increased from 3.87 percent in the period before trade liberalization to 18.24 percent in the period of liberalized trade regime (1990-1994). This documented expansion of exporters fits with the prediction of models of firm heterogeneity in productivity that trade liberalization leads to an expansion in the market share of exporters.

2. Firm-Level Data

The data used in my empirical estimation are compiled from surveys of Ghanaian manufacturing firms for the period of 1991-1997 administered by the Centre for the Study of African Economies (CSAE) at Oxford University. The data set does not provide direct information on firms' level of liquidity, so I cannot control for firms' internal funds in the empirical estimation. To proxy for firms' access to credit, I construct an indicator, called *Overdraft-Loan*, which equals one if the firm has access to overdraft facilities and has no loan

[18] Buchs and Mathisen (2005) provide a very detailed summary and statistics of the banking system in Ghana 1998-2003. This period follows the period I analyze (1992-1997) directly so many of the features of the Ghanaian banking system described in Buchs and Mathisen (2005) are likely to also apply to the period of my empirical application.

[19] According to Fafchamps et al. (1994), bank overdrafts are the biggest source of external finance to Kenyan firms, and that Kenyan firms use their overdraft facility overwhelmingly to finance working capital. While this is just evidence of the role of overdraft in Kenya, the data set of Ghanaian firms that I analyze in this paper also indicates that overdraft is much more common than bank loans for Ghanaian firms.

constraint where loan constraint, defined based on firms' responses to questions about their bank loan applications, includes both firms whose loan applications were rejected and discouraged borrowers. The *Overdraft-Loan* indicator captures firms' constraints in meeting two different types of financing needs: working capital and fixed investments.[20] Overdraft facilities are often used to cover working capital and as a backup for unexpected short-term liquidity shocks. Firms can take their overdraft limits into account when planning liquidity for the future[21], can repay the overdraft debts at any time and only have to pay interest on the actual amount they borrow from the overdraft facility.[22] On the other hand, loans are less flexible in terms and conditions and take a longer time to arrange so they are not often used to cover unexpected cash flow shocks but to finance fixed investments and some anticipated working capital expenditures.[23] Because exporting requires higher working capital and is subject to longer payment delays, having access to overdraft facilities should be more important for exporters. On the other hand, bank loans are important for financing fixed investments needed for exporting. For more detailed definitions and summary statistics of the key variables used in the empirical, see Table 1 and Table 2.

3. Determinants of Credit Access

To examine empirically the factors that affect access to credit of firm *i* in year *t*, I estimate the following regression:

$$CreditAccess_{it} = \alpha_0 + \alpha_1 * X_{i,t-1} + \alpha_2 * Network_{it} + \alpha_3 * T_t + \alpha_4 * S_{it} + \alpha_5 * Area_{it} + \varepsilon_{it} \quad (13)$$

In the specification above, *CreditAccess* is the *Overdraft-Loan* indicator. X is a vector of continuous firm-level regressors: physical capital stock, age, TFP, and raw material costs per worker, as well as an indicator of whether a firm is a limited liability company. All continuous regressors (except firm age) are in logarithms and lagged. *Network* is the number of people firms know that are in one of the following categories: civil servants, politicians, bank officials, in larger businesses, or living outside of Ghana. To avoid extreme values of the network variables,

[20] Overdraft and loan can be set up separately. For example, the Stanbic Bank's web site lists separate information on application procedures for overdraft and loans. In addition, in the data, there are cases where a firm has access to overdraft facilities but did not get a loan or vice versa.

[21] While businesses still need to have accounts with banks in order to have overdrafts with the banks and the overdraft is often linked to the firms' business accounts with the bank, firms can borrow from the overdraft facility more than the amount of money they have in their banking account. Thus, having access to overdraft facilities mean that firms do not have to ensure that sufficient cash is always available for operating activities in the short term.

[22] Source: http://www.stanbic.com.gh/ghana/Business-banking. According to the information on the web site of Stanbic Bank (as of April 2014), a Ghanaian bank, an overdraft is a borrowing facility attached to the firm's bank account, set at an agreed limit. It can be drawn upon at any time and is ideal for the firm's day-to-day expenses, particularly to help the firm through cash flow problems. Although this information is not for the period studied (1991-1997), no historical records of similar information are available, and I have no reason to believe the bank's criteria for granting overdraft and loan access has changed much.

[23] A drawback of the measures of credit constraint used in the empirical testing is that *Overdraft* is binary and thus, do not capture the different degrees of access to credit. The firm's interest payment is a continuous variable and potentially can capture different degrees of credit constraint, so it would be good to include estimation results for regressions using interest payment in the sensitivity analyses. However, in the Ghanaian data set, there is a much higher number of missing observations in interest payment.

values in each network category are winsorized at the 99th percentile.[24] Since the data only include information on firm's network for the years 1994-1997, the regression sample for the regression equation above was limited to those years.

In relation to the theoretical model, capital is a proxy for collateral and affects the bank's credit supply decision. Proxies for firms' productivity such as TFP, age and capital, affect both credit supply and demand. Network affects the bank's evaluation of the firm's productivity, which according to the model, would affect bank's lending decision. While not directly implied in the model, the following variables are included in the regressions to control for further factors that may affect supply and demand of bank credit. Raw material costs per worker are included as a proxy for the firm's need of working capital. A dummy for limited liability companies is included to capture difference in credit access between different ownership forms. Time, sector and regional dummies (*T*, *S* and *Area*) are included to capture the difference across time periods, regions and sectors in credit availability.

It is expected that firms that are older or have large capital stock have easier access to credit.[25] Raw material costs to be positive since a firm with greater need for working capital is more likely to want access to overdraft facilities. The sign of a firm's TFP (or an alternative measure of productivity, value added per worker) is not clear. If all the effects of productivity on access to credit are already captured by a firm's size and age or if banks cannot observe firms' productivity levels, the coefficient of TFP is expected to be insignificant. However, if banks grant credit access based on productivity and can observe or predict firms' TFPs accurately, the coefficient of TFP will be positive. While my model assumes that firms' productivity levels stay constant throughout time, in the empirical estimation, I allow for the evolution of firm productivity by using estimates of TFP using the Levinsohn-Petrin (2003) method that assumes an exogenous Markov process for TFP and accounts for unobserved shocks to input usage.[26] In the remainder of this paper, TFPs refers to estimates of firms' TFPs using the Levinsohn-Petrin (2003) method. People in a firm's network can either provide firms with valuable credit information, or act as reference or guarantee for the firm when the firm applies for overdraft or loans from a bank. Therefore, it is expected that a larger network will help firms have easier access to credit.

The results in Table 3 indicate that firms that are older, larger, or have larger networks are more likely to have access to credit. The effects of TFP and ownership form (limited liability companies) are insignificant. If TFP is replaced by another proxy for firm's productivity, the value added per worker, the estimation results are qualitatively the same.

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[24] For example, for the variable that measures the number of bank officials in the firm's network, I find the 99th percentile of the variable. I then recode every value of this variable that is above this 99th percentile to be equal to the 99th percentile.

[25] I would like to use the ratio of tangible assets over total assets as a proxy for the firm's collateral capacity since this measure is less susceptible to the scale effect than using the level value of physical capital. However, the Ghanaian data set does not have information on financial assets, cash on hand, or intangible assets so I cannot use this measure of tangible asset ratio.

[26] For more information about the procedure for estimating TFPs using the Levinsohn-Petrin (2003) method, see Appendix B.

4. Estimating Equation

Since I am only interested in testing the hypothesis that credit access has a negative effect on firms' export participation rather than the magnitude of this effect, I choose the reduced-form approach as it is adequate to address this question.[27] My model predicts that everything else equal, credit access has a positive impact on export propensity. More precisely, credit access is most important in export participation for firms in the intermediate range of productivity. To test these predictions, I estimate two main regression specifications: a dynamic probit regression of export status and a regression of export status against credit access interacting with quartiles of initial TFPs. In sections 4.1 and 4.2, I will outline these estimating equations.

4.1. Dynamic Probit Regression of Export Status

To test whether credit access has a positive effect on firms' export propensity, I estimate a dynamic probit regression of firms' export status. The estimation results of this regression are valid conditional that there is no reverse causation or simultaneity, which would be checked in Section VI (Sensitivity Analyses). The dynamic probit regression equation to be estimated is:

$$Export_{it} = \beta_0 + \beta_1 Export_{i,t-1} + \beta_2 OverdraftLoan_{it} + \beta_3 X_{i,t-1} + \beta_4 S_{it} + \beta_5 D_t + \eta_i + \varepsilon_{it} \qquad (14)$$

where the subscripts *i* and *t* are firm and time subscripts, *Export* denotes a firm's export status, S_{it} and D_t are the industry and time dummies respectively. X is a vector of control variables such as capital stock to capture the size and productivity effect[28], TFP and firm's age to capture efficiency differences, and weighted education of management to capture differences in management qualities across firms. All the continuous variables are lagged and in logarithms and lagged to alleviate potential simultaneity problems. The error term is composed of a time-invariant unobserved heterogeneity η_i and an idiosyncratic error term ε_{it}.

Lagged export status is included in the estimating equation to account for the persistence of exporting history due to the presence of large sunk costs in entry to exporting and the role of lagged productivity on export status (see Roberts and Tybout 1997, and Nguyen and Ohta 2007).

[27] Related to the rationale for using the reduced-form approach is my rationale for focusing on estimating a single equation of export status instead of estimating a system of equation for export status and other potential endogenous choices such as access to finance. While estimating the export equation as part of a system of equations where the dependent variables in the other equations are other endogenous firm choices yield more efficient estimates under correct specification of all equations, estimation of the export equation alone, if done correctly, should still yield consistent estimates. In the system-of-equation approach, if one equation in the system of equations is misspecified, the estimation of the other equations will be affected by this misspecification (Kennedy 2003, p190). Furthermore, the system of equations approach requires exclusion variables for good identification. Since it is very difficult to model correctly all of the endogenous firm choices and find good exclusion variables for all of the endogenous choices, I choose to adopt the single-equation approach.

[28] The data set I use only covers manufacturing firms and all firms in the data set had output value and paid wages and input costs so none of these firms are "pure" trading intermediaries which do not produce but act as intermediaries between producers and foreign buyers. The export indicator is coded based on the firm's answer to the survey question: "Do you export (some of) your products" so it seems that the export dummy only captures the exporting of the products that firms actually produce. For this reason, I believe we can rule out the case that some exporters in the data are just trading intermediaries.

Industry and time dummies are added to control for different characteristics between different industries, and macro factors that may affect firms' exports. The variable of interest in this regression is the *Overdraft-Loan* indicator.

In my model, there is a one-to-one relationship between firm's size and its productivity so capital can be considered as a proxy for a firm's productivity and so one only needs to control for capital or TFP. However, to allow for the possibility that capital also captures other effects besides the productivity effect such as a scale effect, I also estimate a regression of export decision with both capital and TFP in the right-hand-side as a robustness check. In the theoretical model, more productive firms are less likely to default when facing an adverse export shock z_{it} since they can use their generated profits to overcome the liquidity shocks. Thus, the model implies that more productive firms are more likely to survive to an older age. Therefore, firm age is also included in the regression. Weighted education of the firm's management is included in the regression to control for other firm characteristics.

To deal with the "initial condition" problem present in a dynamic probit regression and the endogeneity of the lagged dependent variable on the RHS due to the presence of persistent unobserved heterogeneity, I follow the approach inWooldridge (2005) by modeling the unobserved time-invariant heterogeneity as a function of the initial value of the dependent variable and time-averages of all exogenous regressors.[29] This method also alleviate the endogeneity concern since it accounts for the correlation between the regressors and the time-invariant unobserved heterogeneity η_i by modeling η_i as a function of the initial value of the dependent variable and the time-averages of all exogenous regressors. Detailed information about this estimation method can be found in *Appendix A*.

Applying this approach, the estimating equation for the dynamic probit regression becomes:

$$\begin{aligned} Export_{it} &= \beta_0 + \beta_1 Export_{i,t-1} + \beta_2 OverdraftLoan_{it} + \beta_3 X_{i,t-1} + \beta_4 S_{it} + \beta_5 D_t \\ &\quad + \beta_6 \overline{X}_{i,t-1} + \beta_7 Export_{i0} + a_i + e_{it} \end{aligned} \qquad (15)$$

where $X_i = \frac{1}{T}\sum_{t=1}^{t=T} X_{i,t-1}$ denotes the time-averages of $X_{i,t-1}$ for each firm *i*, $Export_{i0}$ is the export status of firm *i* in year 1991. Since it is possible that credit access variable is endogenous, I do not include its time-averages in the regression because the Wooldridge (2005) method requires that the unobserved heterogeneity is modeled as a function of only exogenous variables and the initial value of the dependent variable. The error term consists of a firm-specific component (a_i) and an i.i.d component (e_{it}), a_i follows a normal distribution and follows the standard normal distribution $N(0,1)$. Both a_i and e_{it} are independent of all the regressors.

[29] Wooldridge (2005) specifies a more general function form for the time-invariant unobserved firm heterogeneity as a function of the initial value of the dependent variable and all the past, and future values of all exogenous regressors (see Appendix A for more detailed explanation). However, this specification would place too much demand on the data for the Ghanaian data set so I choose to model the time-invariant unobserved heterogeneity as a special case of the Wooldridge's proposal: as a function of the initial value of the dependent variable and time-averages of all exogenous regressors. This is also the approach that is used in many empirial studies using the Wooldridge (2005) method.

Regarding concern about the endogeneity of the TFP measure, since the TFP estimate obtained using the Levinsohn-Petrin (2003) method is a state variable, a contemporaneous shock that is unexpected by the firm, i.e. a shock ε_{it} , will not be correlated with TFP.[30] However, if there are persistent unobserved firm-specific characteristics that influence both export decision and TFP, then TFP will be endogenous. The Wooldridge (2005) method already alleviated this problem of unobserved heterogeneity by modeling the unobserved firm-specific component of the error term (μ_i) as a function of the export status in the initial period and the time-averages of the exogenous regressors. In addition, to address concerns about reverse causation from export to TFP or from export to credit access, or simultaneity between export and productivity, or whether TFP is affected by credit access, I conduct several robustness checks in Section VI (*Sensitivity Analyses*).

4.2. Heterogeneous Effects of Credit Access on Export Propensity

My model predicts that credit access is most important in export participation for firms in the intermediate range of productivity. To test this prediction, I estimate the following linear probability regression:

$$Export_{it} = \alpha_0 + \alpha_1 Export_{i0} + \sum_{j=1}^{4} \alpha_2^j * \Delta OverdraftLoan_{it} * Q_i^j + \alpha_3 Capital_{i,t-1} + \varepsilon_{it} \qquad (16)$$

In the specification above, Q_i^j are indicators that take the value of one if in the initial period of the data set, i.e. in the year 1991, firm *i* has TFP in quartile *j* of the distribution of firms' TFPs in 1991. Using the quartiles of TFP in 1991 reduces the likelihood that TFP is endogenous. $Export_{i0}$ is the export status in year 1991, and Δ denotes first-differencing. While the above specification assumes no sunk costs of exporting, i.e. not including lagged exports on the RHS of the estimating equation, it is good as a suggestive test of whether the impact of access to credit on export propensity is different for firms in different ranges of TFP.[31]

V. Estimation Results

1. Estimation Results for the Dynamic Probit Regression of Export Status

To check robustness of the estimation results for this regression, I estimate the regression equation without credit access measures and with credit access measures, using pooled probit that ignores the initial condition and unobserved heterogeneity, and using Wooldridge (2005)

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[30] For detailed explanation for why the TFP estimates obtained using the Levinsohn-Petrin (2003) method is not correlated with contemporaneous shock, see *Appendix B*.

[31] The Arrelano and Bond (1991) and Blundell and Bond (1998) system GMM method can be used to estimate a dynamic linear probability model. It requires that the associated autocorrelation AR(2) test is insignificant. If the AR(2) test is significant, then lags of the dependent variable, which are used as a subset of the instruments, are endogenous and thus, are not valid instruments. The regression of the dynamic linear probability of export status does not pass the AR(2) test so I cannot estimate this estimating equation in its dynamic form but instead, choose to include the export status in period 1991 in the right-hand-side (RHS).

method for dynamic probit regression. Across all specifications, the role of access to credit is positively associated with higher export propensity.[32]

The estimation results for the pooled probit without the measures of credit access (Table 4) indicate that lagged export and capital are statistically significant and positive, confirming the size effect and the existence of significant sunk costs in exporting. While these estimation results have not controlled for unobserved heterogeneity and thus, tend to overestimate the coefficient of lagged exports, they suggest that firm size and past export history are important in determining firms' export propensities. TFP is positively correlated with export decision but this effect becomes insignificant when past export status is included in the regression, possibly because the effect of TFP on exporting has been picked up by lagged export.[33]

Table 5 presents the regression results ignoring the "initial condition" and unobserved heterogeneity problem when *Overdraft-Loan* is added to the regression. The coefficient estimates for regressors other than *Overdraft-Loan* remain qualitatively the same. The estimate of the coefficient on the *Overdraft-Loan* is statistically significant and positive across all specifications. This provides empirical evidence supporting the paper's hypothesis that credit access has a positive impact on firms' export propensities.

Table 6 presents the estimation results using the Wooldridge (2005) method for dynamic probit regression that addresses the initial condition and the unobserved heterogeneity issues. The results still confirm the positive effect of access to credit on a firm's export propensity. However the coefficient of capital becomes statistically insignificant. This could be due to a high correlation between capital and its time-average, which leads to inefficient estimates of the coefficient on capital. Initial condition does not seem to be a problem in firm's export status for the Ghanaian data since the coefficients on the export status in the year 1991 are insignificant across all regression specifications. There is significant unobserved heterogeneity as shown by the statistically significant estimate of the coefficient of the time-average of TFP. This partly explains why the coefficient of TFP shows up as insignificant.

Table 7 presents the average partial effects (APE) estimates for the dynamic probit regression of export status.[34] Averaged across all time periods and firms, and controlling for unobserved heterogeneity, overdraft and loan access, capital, age, and education of firm's management, the probability that a firm exports in period t is 16.1 percentage points higher if the firm exported in year t-1. Access to overdraft and loans increases the probability of exporting by 9.3 percentage points.

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[32] For a robustness check, I also use firm size categories instead of capital in the regression of firm's export. The firm size categories are defined based on the World Bank's guideline where medium firms are firms with employment between 50 and 100 workers, and large firms employ more than 100 workers. For another robustness checks I also use another firm size categorization by using an indicator of large firm, where the indicator takes value of one if a firm has more than 50 workers. The estimation results remain qualitatively the same for these robustness checks.

[33] This is consistent with the model's prediction that export status is a function of TFP, which means that lagged export status is a function of lagged TFP. Therefore, when both lagged export status and lagged TFP are included in the regression, the effect of TFP goes away.

[34] Information about the calculation of the APEs for a dynamic probit regression can be found in *Appendix A*.

2. The impact of Access to Credit on Exporting Propensity by Quartiles of TFPs

Table 8 confirms the model's second prediction that credit access is most important for firms with productivity levels in the middle range of the productivity distribution. Specifically, the change in credit access only raises the export propensity for firms that have productivity levels in the third quartile of the productivity distribution.

VI. Sensitivity Analyses

1. Examining the Endogeneity of TFP

As mentioned above, because of the method used to calculate TFPs in this paper, the TFP estimates are not correlated with contemporaneous export shocks and thus, they do not suffer from the simultaneity bias problem. However, it is possible that productivity is endogenous due to reverse causation from exporting to productivity also referred to in the literature as learning-by-exporting. If exporting leads to improvement in productivity, I expect the effect would take place in the next period since it takes time for firms to learn from their exporting experience.[35] In other words, exporting in period *t* may lead to an increase in productivity in period *t*+1 but not in period *t*. To investigate this concern, I have included estimation results for estimating equations with and without TFP on the RHS as presented above to see whether results are robust to the inclusion of TFP. I also use lagged TFP to alleviate the simultaneity problem. In addition, I also conducted the following two investigations to rule out the existence of learning-by-exporting in the Ghanaian data set.

First, I estimated a regression of TFP against (1) past export participation and (2) against past export participation, lagged TFP and lagged investment indicator. In both specifications, the coefficient on lagged export status is insignificant (see Table 9). This result is suggestive that reverse causation is not severe with the data used in this paper. Secondly, I re-estimated the TFPs using De Loecker (2013)'s approach. De Loecker (2013) argues that the Levinsohn-Petrin (2003) method for calculating firms' TFP assumes an exogenous evolution of firm productivity and thus, does not allow for the possibility that exporting may affect future productivity. He argues that in order to test for learning-by-exporting, one should at least use TPF estimates derived from a framework that directly allows past export experience to (potentially) affect firms' current productivity. He proposes to model the productivity process as:

$$\omega_{it+1} = g_1(\omega_{it}, E_{it}) + \varepsilon_{it+1} \quad (18)$$

where E_{it} captures a firm's export experience such as an export dummy.[36]

[35] This assumption is widely adopted in the empirical literature that tests for the presence of learning-by-exporting such as De Loecker (2013), and several other studies surveyed in Wagner (2007).

[36] The motion equation for firm's TFP in Olley-Pakes (1996) and Levinsohn-Petrin (2003) is as follows:

$$\omega_{it+1} = g_1(\omega_{it}) + \varepsilon_{it+1}$$

where $g_1(\omega_{it})$ is expected productivity given a firm's information set (which includes any lagged choice variable of the firm) and ε_{it+1} is assumed to be uncorrelated with the information set. De Loecker (2013) arguest that this motion equation does not allow for the possibility that a firm's productivity is impacted by its past export status.

I re-estimated firms' TFPs using the De Loecker (2013) method where g_1 is proxied by a cubic polynomial in productivity and export dummy. Then I regressed the estimated TFP against the variables in the proxy function for the motion equation of TFP, g_1. I expect the coefficient of the regressors that contain the lagged export term to be statistically significant if there is learning from exporting. Since none of these four coefficients are statistically significant (Table 10), I interpret the result as an indication that reverse causation from export to TFP is not present in the Ghanaian data set.

1.3. Addressing the concern that TFP is affected by credit constraint

There may be concern that credit constraint affects TFP. For example, credit constraint may prevent firms from investing in productivity-enhancing activities such as R&D. If this is the case, since productive firms self-select into exporting, my estimate of the impact of credit constraint would be a conservative estimate since it does not include the dynamic effect of credit constraint which reduces TFP and thus, reduces export propensity through the selection effect channel.

To allow for the causation channel from credit constraint to TFP, I re-estimate the TFP under a framework that models the productivity evolution as a function of firm's current TFP and credit access. Specifically, the productivity process is assumed to be:

$$\omega_{it+1} = g_1(\omega_{it}, C_{it}) + \varepsilon_{it+1} \tag{19}$$

where ω is the TFP measure to be estimated, C_{it} is a measure of firms' credit access, ε_{it+1} is an i.i.d shock. In this estimation of TFP, I use the combined *Overdraft-Loan* access indicator as a proxy for firms' credit access, and use a cubic polynomial as a proxy for the function g_1.

It should be noted that in order to obtain consistent estimates of the coefficient of the production function, the Levinsohn-Petrin (2003) method uses input demand as a proxy. The critical assumption for this method to work is that conditional on other state variables (which is just capital in Levinsohn-Petrin (2003) framework), input demand is monotonically increasing in productivity. Since I also use raw material in my estimation as a proxy, my estimation of TFP will only be valid if input demand is monotonically increasing in productivity conditional on capital and credit access. When the credit access indicator equals one, this assumption is likely to be valid since a firm with credit access is likely to be able to purchase the amount of inputs needed for first-best output level. Since output is monotonically increasing in the firm's productivity, the input demand is also monotonically increasing in the firm's productivity for firms with access to credit. However, the monotonic relationship between a firm's productivity and its input usage may break down for firms without credit access when credit access depends not only on productivity but also other factors. Despite this limitation, this test is still a good robustness check to see whether credit constraint affected firm's TFP for the firms in my data set.

To test whether credit access affects the evolution of TFP, I regressed the *TFP* estimated under the above framework against all the terms in the polynomial g_1. If credit constraint had important impact on TFP evolution in the Ghana data set, I would expect at least one of the coefficients of the regressors that contain lag of Overdraft-Loan to be statistically significant.

Since these coefficients are not statistically significant (see Table 11), I interpret the result to suggest that credit access does not influence the evolution of TFP in this case.[37]

2. Examining the Endogeneity of Credit Access Measures

To check whether there is reverse causation from past export to credit access, I conducted propensity-score matching. Matching provides a good control group and eliminates endogeneity bias caused by observable firm characteristics.[38] In matching, the treatment is the *Overdraft* indicator, and the matching covariates include lagged export status and other factors that may affect a firm's access to credit such as the size of a firm's network, age, the lag of the natural logarithm of capital, and lagged export status. The outcomes are export variables in the next period including export status, export intensity, percentage of the firm's output exported to other African countries, and percentage of the firm's output exported to countries outside of Africa. The average treatment effects on the treated (ATT) estimates for most export outcomes (export status, export intensity for all export destinations, and export intensity for export to countries outside of Africa) are all statistically significant and positive (see Table 12). Since the matching controls for lagged export status, the matching results provide some confidence that the positive relationship between access to credit and export status is not driven by reverse causation from export to access to credit access. Interestingly, the ATT for export intensity of exports to countries in Africa is insignificant. This result points to a story of the important role of overdraft in financing working capital for exporting. Exporting to outside Africa involves a longer shipping time and thus, longer lag time until a firm receives payment for its export sales. This increases the firm's need for financing of working capital relative to the case of exporting to other African countries. Therefore, having access to overdraft facilities should impact the export intensity for exporting to countries outside of Africa more than it impacts the export intensity for exporting to countries within Africa.

VII. Conclusion

In this paper, I build a theoretical model of firms that are heterogeneous in productivity, internal funds, and collateral with endogenous lending and borrowing. The model predicts that credit constraint has a negative impact on firms' export propensity. More importantly, credit constraint diminishes the selection of productive firms into exporting markets. Less productive firms are able to export due to having higher internal funds or collateral, while more productive firms with less financial or collateral resources stay domestic. Thus, the model implies that trade liberalization without improving the financial system would result in smaller gains from trade.

The empirical section of the chapter looks at the impact of having access to both bank overdraft and loans on a firm's export propensity in Ghana. While access to bank loans has been widely studied, access to overdraft has received little study. Yet, bank overdraft has been documented to be a popular financial instrument for firms in Ghana and some other developing countries, such as Kenya (Fafchamps et al. 1994). I find that access to credit has a significant impact on firms' export propensity. This result is robust to many different sensitivity analyses.

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[37] The correlations between different TFP measures are high, between 0.7 and 0.8.

[38] Merits of matching method are discussed in Blundell and Costa Dias (2000). A number of empirical studies have applied matching in investigating the effects of export such as Girma et al. (2004), Greenaway et al. (2005), or Yasar and Rejesus (2005).

The effect of access to credit is heterogeneous: it increases firms' export propensity but only for firms in the intermediate range of productivity (the third quartile of TFP distribution). I also find that besides the conventional factors that affect a firm's access to credit, such as firm size, age and location, there is evidence for the existence of relationship-based lending in Ghana as network is found to have a positive effect on firm's access to bank credits.

While this paper only looks at the static effect of credit access on firms' export decisions, the effects of credit constraint would be even larger if there is a positive feedback between exporting and firms' performance. Future research could look into this dynamic impact of credit constraint in other economies. Another interesting research direction, conditional on more data availability, is to look at the cost components of exporting and break these down into different types of costs that are funded with different financial instruments. If financing these costs components has a different degree of importance to the firm's ability to export, access to different types of financial instruments would also have a different level of importance to the firm's exporting. Another focus of future research would be to evaluate the relative importance of credit constraint against other potential obstacles to exporting.

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Table 1 – Definitions of Regression Variables

Variable Name	Definition
Export	An Indicator of firm's export status which takes a value of one if the firm exports and zero if the firm does not export in the year.
Capital	Firm's physical capital stock
Overdraft-Loan	An indicator that takes value of one if a firm has access to overdraft facilities and faces no constraint in getting a bank loan. Firms are considered to face constraint in getting a bank. These constrained firms consist of firms that are quantity rationed, risk-rationed or transaction-cost rationed in access to bank loans. Firms that are quantity rationed are either those that applied for a formal loan and were rejected or those that did not apply for a loan because of one or a combination of the following reasons: inadequate collateral, the firm did not think it would get a loan, or the firm was already heavily indebted. Firms that are transaction-cost rationed are those that did not apply for a loan because "the process was too difficult". Firms that are risk rationed are those that did not apply for a loan because they did not want to incur debt.
TFP	Firm's total productivity factor obtained using the Levinsohn-Petrin (2003) method[39]
Management Education	Weighted average education of a firm's management

Table 2 – Descriptive Statistics for Key Variables (1992-1997)

	Mean	Standard Deviation
Export	0.12	0.32
Overdraft-Loan	0.19	0.39
Capital (million US dollars)	9.75	54.77
TFP (thousand US dollars)	5.44	9.49
Firm Age	16.37	11.72
Education of Firm's Management	14.47	1.82

Notes: N=740. Capital, TFP are in 1991 US dollars.

[39] Note that TFP can also be estimated using the Olley and Pakes (1996) method. However, this method restricts the sample to only firms with positive investments. Since the number of firms with missing or zero investments is substantial in the sample while the number of firms with missing raw material costs is close to zero, I choose to use the Levinsohn-Petrin method.

Table 3 – Determinants of Access to Credit

	(1) Overdraft-Loan	(2) Overdraft-Loan
Capital	0.225***	0.236***
	(0.05)	(0.05)
Age	0.387**	0.435**
	(0.13)	(0.13)
Raw Material Costs per Worker	0.151	0.251*
	(0.10)	(0.10)
TFP	0.145	
	(0.09)	
Limited Liability	0.001	0.020
	(0.24)	(0.24)
Network Size	0.005*	0.004*
	(0.00)	(0.00)
Value Added per Worker		0.047
		(0.10)
N	485	468

Notes: * $p < 0.05$, ** $p < 0.01$, *** $p < 0.001$. Sector, region and year dummies, and an intercept term are included in all regressions. Capital, TFP, raw material costs per worker, and value added per worker are lagged, and in logarithms. Firm age is in logarithms.

Table 4 – Regression of Export Status without Credit Access Variables (Pooled Probit)

	(1) Export	(2) Export	(3) Export	(4) Export	(5) Export	(6) Export
Physical Capital	0.187***	0.149**	0.120**	0.103*	0.118**	0.103*
	(0.05)	(0.05)	(0.04)	(0.04)	(0.04)	(0.05)
TFP		0.209*		0.091		0.093
		(0.10)		(0.09)		(0.08)
Lagged Export			2.026***	2.044***	2.036***	2.052***
			(0.20)	(0.20)	(0.21)	(0.21)
Age					0.006	-0.015
					(0.12)	(0.12)
Management Education					0.015	0.016
					(0.04)	(0.05)
Constant	-4.044***	-5.803***	-3.415***	-4.189***	-3.633***	-4.401***
	(0.98)	(1.31)	(0.76)	(1.02)	(0.94)	(1.13)
Observations	740	737	740	737	740	737

Notes: * $p < 0.05$, ** $p < 0.01$, *** $p < 0.001$. Capital, TFP are lagged, and in logarithms. Age is in logarithm and Management Education is lagged. Sector and year dummies are included in all regressions. Standard errors are clustered by firm.

Table 5 – Regression of Export Status with Overdraft-Loan Indicator – Pooled Probit Estimation

	(1) Export	(2) Export	(3) Export	(4) Export	(5) Export	(6) Export
Physical Capital	0.121*	0.103	0.052	0.049	0.050	0.049
	(0.05)	(0.05)	(0.05)	(0.05)	(0.05)	(0.05)
Overdraft-Loan	0.760**	0.649**	0.784**	0.763**	0.783**	0.761**
	(0.24)	(0.22)	(0.26)	(0.26)	(0.26)	(0.26)
TFP		0.151		0.019		0.020
		(0.09)		(0.08)		(0.08)
Lagged Export			2.046***	2.092***	2.053***	2.096***
			(0.21)	(0.20)	(0.21)	(0.21)
Age					0.013	-0.008
					(0.13)	(0.13)
Management Education					0.010	0.008
					(0.05)	(0.05)
Constant	-3.164**	-4.547***	-2.532**	-2.717**	-2.681**	-2.831*
	(0.97)	(1.24)	(0.78)	(1.02)	(0.98)	(1.12)
Observations	740	737	740	737	740	737

Notes: * $p < 0.05$, ** $p < 0.01$, *** $p < 0.001$. Capital, TFP are lagged, and in logarithms. Age is in logarithm and Management Education is lagged. Sector and year dummies are included in all regressions. Standard errors are clustered by firm.

Table 6 – Estimation of the Dynamic Probit with Overdraft-Loan Indicator

	(1) Export b/se	(2) Export b/se	(3) Export b/se	(4) Export b/se
Lagged Export	1.427***	1.502***	1.427***	1.488***
	(0.32)	(0.33)	(0.33)	(0.33)
Physical Capital	-0.214	-0.182	-0.212	-0.197
	(0.62)	(0.64)	(0.65)	(0.66)
Overdraft-Loan	0.835**	0.768*	0.867**	0.801*
	(0.31)	(0.33)	(0.32)	(0.34)
Export in 1991	0.340	0.288	0.325	0.276
	(0.51)	(0.54)	(0.51)	(0.54)
Average of Physical Capital	0.361	0.274	0.359	0.293
	(0.64)	(0.65)	(0.66)	(0.68)
TFP		-0.289		-0.296
		(0.16)		(0.16)
Average of TFP		0.698*		0.727*
		(0.29)		(0.30)
Age			0.096	0.061
			(0.24)	(0.25)
Management Education			0.019	-0.005
			(0.06)	(0.06)
Average of Management Education			-0.180	-0.246
			(0.21)	(0.22)
Constant	-4.576**	-8.470**	-2.537	-5.356
	(1.52)	(2.95)	(3.01)	(3.77)
lnsig2u				
Constant	0.016	0.088	0.030	0.099
	(0.61)	(0.63)	(0.61)	(0.63)
Observations	740	737	740	737

Notes: * $p < 0.05$, ** $p < 0.01$, *** $p < 0.001$. Capital, TFP are in logarithm, and lagged. Age is in logarithm and Management Education is lagged. Average refers to time-averages of the variable for each firm. Sector and year dummies are included in all regressions. Standard errors are clustered by firm.

Table 7 – Average Partial Effects (APEs) for the Dynamic Probit Regression of Export Status

	APE
Lagged Export	0.161*
	(0.072)
Overdraft-Loan	0.093*
	(0.037)
Capital	-0.016
	(0.026)
Observations	740

Notes: * $p < 0.05$, ** $p < 0.01$, *** $p < 0.001$. Capital is in logarithm, and lagged. Reported standard errors are panel bootstrap standard errors with 500 replications.

Table 8 – Heterogeneous Effects of Access to Credit

	Export
Export in 1991	0.203**
	(0.06)
Physical Capital	0.021**
	(0.01)
ΔOverdraftloan*Q_1	0.010
	(0.07)
ΔOverdraftloan*Q_2	0.076
	(0.06)
ΔOverdraftloan*Q_3	0.080*
	(0.04)
ΔOverdraftloan*Q_4	0.006
	(0.03)
N	740

Notes: * $p < 0.05$, ** $p < 0.01$, *** $p < 0.001$. Capital is in logarithm, and lagged. ΔOverdraftloan is the change in the value of Overdraft-Loan indicator between wave 2 and wave 1. Q1, Q2, Q3 and Q4 are dummies referring to the first, second, third and fourth quartiles of firms' TFPs in the year 1991. An intercept term, sector and year dummies are included in all regressions. Standard errors are clustered by firm.

Table 9 – Checking Reverse Causation from Lagged Export status to TFP

	(1) TFP (log) b/se	(2) TFP (log) b/se	(3) TFP (log) b/se	(4) TFP (log) b/se
Lagged Export	0.042	0.229	0.045	0.209
	(0.16)	(0.14)	(0.16)	(0.14)
Lag of Logarithm of TFP		0.625***		0.606***
		(0.08)		(0.08)
Lag of Investment Indicator			0.039	0.154
			(0.08)	(0.11)
Observations	737	737	737	737
AR(2) (p-value)		0.511		0.480
Sargan (p-value)		0.214		0.140
Hansen (p-value)		0.171		0.280

Notes: * $p < 0.05$, ** $p < 0.01$, *** $p < 0.001$. Investment Indicator is an indicator of whether the firm invested in plant or equipment. Although not presented in the table, an intercept term is included in the regression. Columns 1 and 3 are fixed-effect estimations. Columns 2 and 4 are Arellano-Bond's GMM estimates of the dynamic linear regression. Standard errors are clustered by firm. AR(2) is the Arellano and Bond test of second order autocorrelation. Sargan (p-value) and Hansen (p-value) is the p-value of the Sargan and Hansen tests of overidentification restrictions.

Table 10 – Checking Reverse Causation from Lagged Export status to TFP (Continued) – Regression of TFP According to the Fitted Evolution Equation of TFP

	(1) TFP_NP
Lag of TFP_NP	1.979***
	(0.18)
Lag of TFP_NP squared	-0.196***
	(0.04)
Lag of TFP_NP cubed	0.009***
	(0.00)
Lag of Export	7.820
	(14.21)
Lag of TFP_NP * Lag of Export	-3.730
	(5.36)
Lag of TFP_NP squared * Lag of Export	0.551
	(0.67)
Lag of TFP_NP cubed * Lag of Export	-0.026
	(0.03)
Observations	624

Notes: * $p < 0.05$, ** $p < 0.01$, *** $p < 0.001$. Sector and year dummies are included in all regressions. TFP_NP is the estimates of TFP where the motion equation for TFP is a cubic polynomial of TFP and export status.

Table 11 – Checking Whether Credit Constraint Affects TFP – Regression of TFP According to a Fitted Evolution Equation of TFP where Credit Access is Included in the Motion Equation of TFP

	TFP_CC
Lag of TFP_CC	2.064***
	(0.22)
Lag of TFP_CC squared	-0.192***
	(0.05)
Lag of TFP_CC cubed	0.008**
	(0.00)
Lag of Overdraft-Loan Dummy	30.542
	(43.48)
Lag of TFP_CC* Lag of Overdraft-Loan	-10.860
	(14.00)
Lag of TFP_CC squared*Lag of Overdraft-Loan	1.243
	(1.49)
Lag of TFP_CC cubed*Lag of Overdraft-Loan	-0.046
	(0.05)
Observations	624

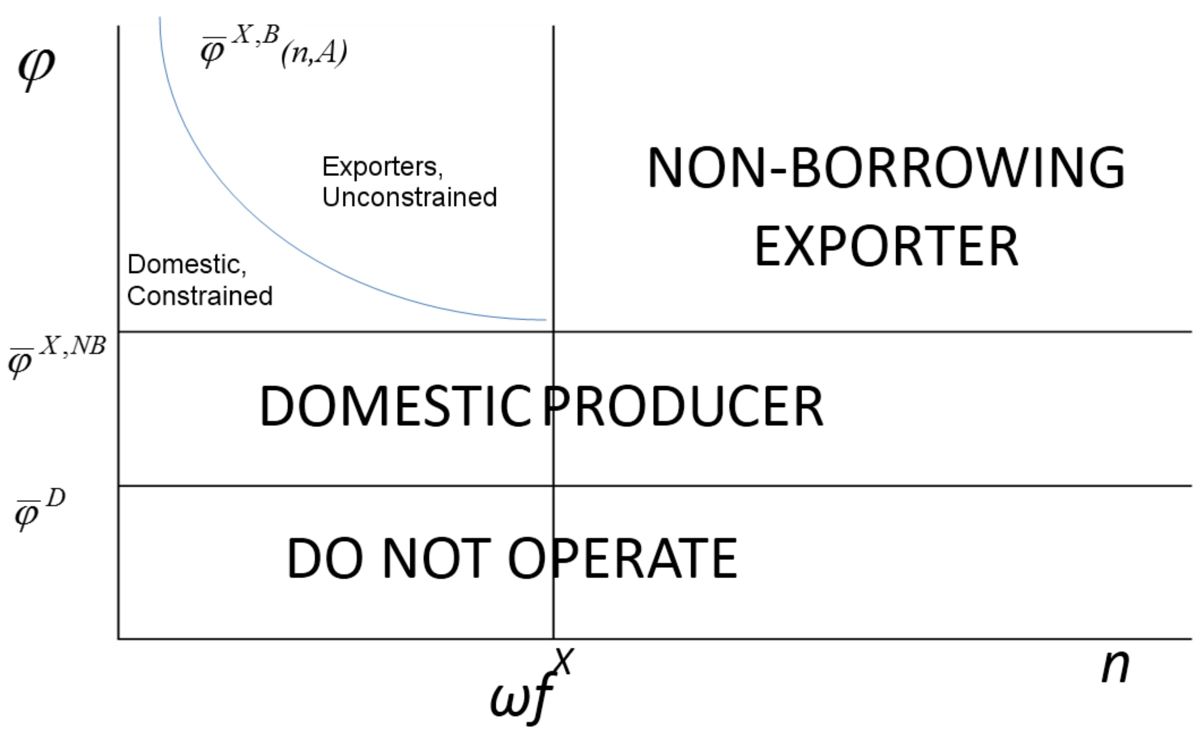
Notes: * $p < 0.05$, ** $p < 0.01$, *** $p < 0.001$. Sector and year dummies are included in all regressions. TFP_CC is the estimates of TFP where the motion equation for TFP is a cubic polynomial of TFP and the Overdraft-Loan indicator.

Table 12 – Propensity Score Matching – Treatment is Access to Overdraft in 1995

	(1) Export Status in 1995	(2) Exports to African countries in 1995 (% of output)	(3) Exports to countries outside Africa in 1995(% of output)	(4) Export Intensity in 1995 (% of output)
ATT				
	0.194*	1.500	7.667*	9.166**
	(0.09)	(0.79)	(3.05)	(3.09)
Observations	135	135	135	135

Notes: * $p < 0.05$, ** $p < 0.01$, *** $p < 0.001$. ATT is average treatment effects on the treated. Matching Covariates are lagged export status, capital, firm age, and number of bank officials who are in the firm's network in year 1994.

Figure 1 – Exporting Decision as a Function of Firm's Productivity and Liquidity



Appendix A – Estimation Issues and Solutions

Several estimation issues need to be addressed in estimating the dynamic probit regression outlined above. First, the inclusion of lag value of the dependent variable as a regressor leads to the "initial condition problem", where the likelihood function of a dynamic probit is conditional on the initial value of the dependent variable at time *t*=0, denoted as y_{i0} and the first period in the data sample does not coincide with the initial period of the dynamic process. To obtain consistent estimates from maximizing the likelihood function requires making a decision on how the initial observations y_{i0} will be treated.

Secondly, even though I have included industry and time dummies as well as controlling for some firm characteristics such as firm size, age, TFP and the education of the firm's management, it is very likely that there still exist unobserved firm-specific characteristics that affect its export decisions. These characteristics are likely to persist over time. This unobserved heterogeneity component is denoted as η_i in the regression equation in the chapter. In order to obtain consistent estimates, one needs to integrate the firm's unobserved heterogeneity out of the likelihood function. If the strong assumption that the initial conditions are exogenous holds, i.e., that η_i is independent of y_{i0}, then estimates from a standard random effects probit estimation command such as *xtprobit* in *Stata* will be consistent. However, in the context of this chapter, η_i is likely to be correlated to y_{i0} since firm's unobserved heterogeneity are likely to affect the firm's propensity to export in the first survey period. If we ignore this correlation, the estimates obtained will be inconsistent.

To deal with the initial condition problem in the presence of unobserved heterogeneity, i.e. the first and second estimation issue, I use the estimation method proposed by Wooldridge (2005), which models the unobserved time-invariant heterogeneity as a function of the initial value of the dependent variable and time-averages of all exogenous regressors.[40] This method also alleviate the fourth estimation issue since it accounts for the correlation between the regressors and the time-invariant unobserved heterogeneity η_i by modeling η_i as a function of the initial value of the dependent variable and the time-averages of all exogenous regressors. Detailed information about this estimation method can be found in *Appendix A*.

The strength of the estimator proposed by Wooldridge (2005) is that it leads to a straightforward regression equation that can be estimated by any standard software and thus, is much less time and computing intensive. It solves the problem of unobserved heterogeneity and the problem of initial condition and yields consistent estimates. In addition, the method does not require exclusion variables (for the initial period) outside of the regression equation for the following periods. Given that these exclusion variables must satisfy the condition that they

[40] Wooldridge (2005) specifies a more general function form for the time-invariant unobserved firm heterogeneity as a function of the initial value of the dependent variable and all the past, and future values of all exogenous regressors (see Appendix A for more detailed explanation). However, this specification would place too much demand on the data for the Ghanaian data set so I choose to model the time-invariant unobserved heterogeneity as a special case of the Wooldridge's proposal: as a function of the initial value of the dependent variable and time-averages of all exogenous regressors. This is also the approach that is used in many empirial studies using the Wooldridge (2005) method.

correlate with the value of the dependent variable in the first period, but are not correlated to subsequent values of the dependent variables in the following periods, it is often very hard to find convincing exclusion variables in practice.

On the other hand, the Wooldridge (2005) method cannot yield estimates for time-invariant regressors (since the value of these regressors are the same as their time-averages) and requires strict exogeneity of the regressors.[41] It also does not allow for the feedback of current value of the dependent variable to the future values of the explanatory variables. These assumptions may be violated in the context of this chapter if a firm's current export activity affects its access to credit in the future.

Compared to another method proposed by Heckman (1981) for estimating dynamic probit by modeling the initial value of the the dependent variable, the Wooldridge (2005) method imposes a slightly stricter assumption on the unobserved firm fixed effect. However, the Heckman (1981) method is more computational intensive and requires exclusion variables for the initial period(s). In pracitce, it is hard to find convincing exclusion variables that affect export participation in the initial period, but do not affect export participation in the following periods. Furthermore, several studies that compare different methods used to estimate a dynamic probit model conclude that the Wooldridge (2005) method is as good as the Heckman (1981) method when the time length of the panel data is moderately long or long, i.e. when $T \geq 5$ (see for example, Akay 2009). The data set I have has 6 time periods so estimation using the Wooldridge method is a reasonable choice. Because of the reasons above, I choose to use the Wooldridge (2005) method.[42]

Dating the observations starting at t=0 so that $Export_{i0}$ is the first observation on firm export status. For t=1, …, *T*, the regression equation can be rewritten as:

$$Export_{it} = \beta_1 Export_{i,t-1} + X_{it}\delta + \eta_i + \varepsilon_{it}$$

and the probability of firm's participation in exporting can be written as:

$$P(Export_{it} = 1 \mid Export_{i,t-1}, Export_{i,t-2}, ..., Export_{i0}, X_i, \eta_i) = G(\beta_1 Export_{i,t-1} + X_{it}\delta + \eta_i)$$

where *G* is the probit function. X_{it} is a vector of contemporaneous explanatory variables, and $X_i = (X_{i1}, X_{i2}, ..., X_{iT})$

Note that the specification above allows for the probability of exporting to depend on the export status in *t*-1 and on unobserved heterogeneity η_i. The above model requires that conditional on firm's time-invariant fixed effect η_i, X_{it} satisfy a strict exogeneity assumption.

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[41] Although the Wooldridge (2005) method cannot yield estimates for time-variant regressors, including these regressors where relevant will improve the quality of the estimates.

[42] The data set is actually from 1991-2002 but the surveys after 1997 is carried out every three years instead of every two years and there are many changes in the questionnaire for the years 1998-2002.

The likelihood function can be written as:

$$f(y_1, y_2, ..., y_T \mid y_0, X, c; \beta) = \prod_{t=1}^{T} f(y_t \mid y_{t-1}, ..., y_1, y_0, X_t, \eta; \beta)$$

$$= \prod_{t=1}^{T} G(\beta_1 Export_{t-1} + X_i\delta + \eta)^{y_t} \left[1 - G(\beta_1 Export_{t-1} + X_i\delta + \eta)\right]^{1-y_t}$$

To obtain consistent estimator, it is necessary that the unobserved heterogeity is integrated out of the likelihood function above since if we just treat this unobserved heterogeneity as a paramenter to be estimated, the estimators of β_1 and δ will be inconsistent.

When integrating the unobserved heterogeneity out of the distribution, we have to deal with the initial conditions problems, i.e. how to treat the initial observation of the dependent variable $Export_{i0}$.

Wooldridge (2005) proposes to model the unobserved heterogeneity as follows

$$\eta_i = \psi + \xi_0 Export_{i0} + X_i\xi + a_i$$

where a_i ~ Normal$(0, \sigma_a^2)$ and independent of (y_{i0}, X_i). Given this assumption of the conditional distribution of firm's unobserved heterogeneity, we can write

$$Export_{it} = 1(\psi + \beta_1 Export_{i,t-1} + X_{it}\delta + \xi_0 Export_{i0} + X_i\xi + a_i + e_{it} > 0)$$

and thus, the regression can now be estimated with standard random-effect probit software by simply expanding the list of regressors to include $Export_{i0}$, and X_i in each time period.

Because of the limited number of observations in the data set, including all the history of the regressors in the regression takes up a lot of degrees of freedom. Therefore, I choose to adopt a more specific assumption of the initial condition that has been used by many authors in estimating a dynamic probit using Wooldridge (2005) method. In particular, I assume that

$$\eta_i = \psi + \xi_0 Export_{i0} + \overline{X}\lambda + a_i$$

where $\overline{X}$ denotes time-average of the exogenous regressors.

This leads to the following regression equation:

$$Export_{it} = 1(\psi + \beta_1 Export_{i,t-1} + X_{it}\delta + \xi_0 Export_{i0} + \overline{X}\lambda + a_i + e_{it} > 0)$$

The regression can now be estimated with standard random-effect probit software by simply expanding the list of regressors to include $Export_{i0}$, and the time-average values of each exogenous regressor.

To calculate the average effect, I use the following approach outlined in Wooldridge (2010) by first, averaging out the initial condition. Denote Φ and ϕ as the c.d.f and p.d.f of a standard normal random variable. Then the Average Structural Function

$$ASF = E\left[\Phi(\psi_a + \beta_{1a} Export_{i,t-1} + X_{it}\delta_a + \xi_{0a} Export_{i0} + \overline{X}\lambda_a)\right]$$

can be consistently estimated as

$$A\hat{S}F = \frac{1}{N}\sum_{i=1}^{N}\Phi\left(\hat{\psi}_a + \hat{\beta}_{1a} Export_{i,t-1} + X_{it}\hat{\delta}_a + \hat{\xi}_{0a} Export_{i0} + \overline{X}\hat{\lambda}_a\right)$$

where $\hat{\psi}$, $\hat{\beta}_1$, $\hat{\delta}$, $\hat{\xi}_0$ $\hat{\lambda}$ are the original coefficient estimates reported by Stata for the random effects probit including $Export_{i0}$, and the time-average values of each exogenous regressor. The subscript *a* on $\hat{\psi}$, $\hat{\beta}_1$, $\hat{\delta}$, $\hat{\xi}_0$ $\hat{\lambda}$ denotes the values where the original coefficient estimates have been multiplied by $(1+\hat{\sigma}_a^2)^{-1/2}$ with the value of $\hat{\sigma}_a^2$ obtained from Stata regression output.

Let X_1 be an indicator variable that is one of the regressors. To calculate the APE (average partial effects) for X_1, we can estimate the difference in the $A\hat{S}F$ when $X_1 = 1$ and the $A\hat{S}F$ when $X_1 = 0$. To obtain a single APE, this difference is then averaged out over time periods. For example, to obtain the APE of the lag exports, we calculate

$$\Phi\left(\hat{\psi}_a + \hat{\beta}_{1a} + X_{it}\hat{\delta}_a + \hat{\xi}_{0a} Export_{i0} + \overline{X}\hat{\lambda}_a\right) - \Phi\left(\hat{\psi}_a + X_{it}\hat{\delta}_a + \hat{\xi}_{0a} Export_{i0} + \overline{X}\hat{\lambda}_a\right)$$

for each observation, then average this value across all firms and all time periods.

For continuous regressors, the APE can be obtained by taking derivatives of the $A\hat{S}F$ with respect to the regressor we are interested in. For example, if X_2 is a continuous regressor and $\hat{\delta}_{a1}$ is its re-scaled coefficient estimate then the APE for X_2 is the average across all firms and all time periods of $\hat{\delta}_{a1}\phi\left(\hat{\psi}_a + \hat{\beta}_{1a} + X_{it}\hat{\delta}_a + \hat{\xi}_{0a} Export_{i0} + \overline{X}\hat{\lambda}_a\right)$

Appendix B – Levinsohn-Petrin method for obtaining firm's unobserved productivity

Stage one:

1. Run a locally weighted least square regression of y_t on m_t and k_t to obtain an estimate of the function $E(y_t|m_t, k_t)$.

2. Run a regression of l_t on m_t and k_t to obtain an estimate of the function $E(l_t|m_t, k_t)$.

3. Construct $Y_t = y_t - E(y_t|m_t, k_t)$ using the estimate of the conditional expectation from the regression in step 1. This is the dependent variable in step 4. Similarly, difference out the predicted mean for each of the explanatory variables, and use these differences as explanatory variables for the regression in step 4.

4. Run no-intercept OLS regressing the constructed dependent variable *Y* on the vector of constructed independent variables. The key estimated parameters from this stage are the

production function parameters on all the variable inputs except the intermediate proxy, raw materials.

Stage two:

1. Compute the estimate of $\phi_t(m_t, k_t)$. To do so use the appropriate observations and (some form of) regression to predict $y_t - \beta_l l_t = \phi_t + \eta_t$ using (m_t, k_t) as explanatory variables. Save the estimate $\hat{\phi}_t$.

2. Choose a candidate value for (β_m, β_k), say (β_m^*, β_k^*). A good starting value might be the OLS value from a Cobb-Douglas production function.

3. Compute $\omega_t \hat{+} \eta_t = y_t - \beta_l l_y - \beta_m^* m_t - \beta_k^* k_t$. Call the variable just computed "*A*".

4. Compute $\hat{\omega}_{t-1} = \hat{\phi}_{t-1} - \beta_m^* m_{t-1} - \beta_k^* k_{t-1}$. Call this variable *"B"*.

5. Regress *A* on *B* using use locally weighted least squares. Call the predicted values *"C"*. "C" is an estimate of $E(\omega_t|\omega_{t-1})$.

6. Compute ($\xi_t \hat{+} \eta_t$) by substituting *C* in for $E(\omega_t|\omega_{t-1})$ to obtain

$$\xi_t \hat{+} \eta_t(\beta_m^*, \beta_k^*) = y_t - \beta_l l_y - \beta_m^* m_t - \beta_k^* k_t - E(\omega_t|\omega_{t-1})$$

This is the residual that enters the moment equation. Use it to construct the sample analogues to the population moment conditions.

7. Using a minimization routine, choose ($\hat{\beta}_m, \hat{\beta}_k$) to minimize the following GMM objective function:

$$Q(\beta_m^*, \beta_k^*) = Min_{\beta_m^*, \beta_k^*} \sum_{h=1}^{h=5} \left(\sum_i \sum_{t=T_{i0}}^{t=T_{il}} \left(\xi_t \hat{+} \eta_{it} (\beta_m^*, \beta_k^*) Z_{i,ht} \right) \right)^2$$

where $Z_t = (k_t, m_{t-1}, l_{t-1}, k_{t-1}, m_{t-2})$.

This will involve iterations over the previous six steps.

Appendix C – Proofs

1. Solving firm's decision whether to borrow for export or to produce only domestically

$$V_t^{X,B}(n,\varphi,r_{it}) = \frac{1}{1-\beta(1-p)(1-\Phi^{X,B})}\left[\pi^D + p^X y^X - \frac{\omega\tau * y^X}{\varphi} - (1+r_{it})\omega f^X + (1+r_0)n\right] - f^{ex}$$

$$V_t^D(n,\varphi) = \frac{1}{1-\beta(1-p)}\left[\pi^D + (1+r_0)n\right]$$

where f^{ex} is the sunk cost of entry into the foreign market.

$$\pi^D = p^D(\varphi) y^D(\varphi,\overline{\varphi}^D) - \frac{\omega * y^D(\varphi,\overline{\varphi}^D)}{\varphi} - \omega f^D$$

To simplify, in the following part of this section, Φ refers to $\Phi^{X,B}$, the probability of default for a borrowing exporter.

A firm decides to borrow for export if $V_t^{X,B}(n,\varphi,r_{it}) \geq V_t^D(n,\varphi)$. Otherwise, the firm decides to produce only for the domestic market. Using algebra:

$$V_t^{X,B}(n,\varphi,r_{it}) - V_t^D(n,\varphi)$$
$$= \frac{-\Phi\beta(1-p)\{\pi^D + (1+r_0)n\} + [1-\beta(1-p)]\pi^{X,B} - [1-\beta(1-p)(1-\Phi)][1-\beta(1-p)]f^{ex}}{\{1-\beta(1-p)(1-\Phi)\}\{1-\beta(1-p)\}}$$

where

$$\pi^{X,B} = p^X y^X - \frac{\omega\tau * y^X}{\varphi} - (1+r_{it})\omega f^X = \frac{r^{X,B}}{\mu} - (1+r_{it})\omega f^X$$

So $V_t^{X,B} \geq V_t^D$ if and only if:

$$D = -\Phi\beta(1-p)\{\pi^D + (1+r_0)n\} + [1-\beta(1-p)]\pi^{X,B} - [1-\beta(1-p)(1-\Phi)][1-\beta(1-p)]f^{ex} \geq 0$$

Note that

$$\frac{\partial \pi^{X,B}}{\partial \varphi} = \frac{\partial\left(\frac{r^{X,B}}{\mu} - (1+r_{it})\omega f^x\right)}{\partial \varphi} = \frac{1}{\mu}\frac{\partial r^{X,B}}{\partial \varphi} - \omega f^X \frac{\partial r_{it}}{\partial \varphi}$$

where $r^{X,B}$ is the revenue from exporting by borrowing.

Similarly, let r^D be the revenue from selling to the domestic market then:

$$\frac{\partial \pi^D}{\partial \varphi} = \frac{\partial\left(\frac{r^D}{\mu} - \omega f^D\right)}{\partial \varphi} = \frac{1}{\mu}\frac{\partial r^D}{\partial \varphi}$$

We also know that:

$$r^{X,B} = \tau^{1-\mu} r^D$$

so $\frac{\partial r^{X,B}}{\partial \varphi} = \tau^{1-\mu}\frac{\partial r^D}{\partial \varphi}$

Using the above formula to take derivative of *D* with respect to φ:

$$\frac{\partial D}{\partial \varphi} = -\Phi\beta(1-p)\frac{\partial \pi^D}{\partial \varphi} - \beta(1-p)\{\pi^D + (1+r_0)n\}\frac{\partial \Phi}{\partial \varphi} + [1-\beta(1-p)]\frac{\partial \pi^{X,B}}{\partial \varphi}$$

$$\frac{\partial D}{\partial \varphi} = \frac{-\Phi\beta(1-p)}{\mu}\frac{\partial r^D}{\partial \varphi} - \beta(1-p)\{\pi^D + (1+r_0)n\}\frac{\partial \Phi}{\partial \varphi} + [1-\beta(1-p)]\left[\frac{1}{\mu}\tau^{1-\mu}\frac{\partial r^D}{\partial \varphi} - \omega f^X\frac{\partial r_{it}}{\partial \varphi}\right]$$

$$\frac{\partial D}{\partial \varphi} = \frac{1}{\mu}\{-\Phi\beta(1-p) + [1-\beta(1-p)]\tau^{1-\mu}\}\frac{\partial r^D}{\partial \varphi} - \beta(1-p)\{\pi^D + (1+r_0)n\}\frac{\partial \Phi}{\partial \varphi}$$
$$-[1-\beta(1-p)]\omega f^X\frac{\partial r_{it}}{\partial \varphi}$$

Since $\frac{\partial \Phi}{\partial \varphi}$<0 and $\frac{\partial r_{it}}{\partial \varphi} < 0$, $-\beta(1-p)\{\pi^D + (1+r_0)n\}\frac{\partial \Phi}{\partial \varphi}$>0 and $-[1-\beta(1-p)]\omega f^X\frac{\partial r_{it}}{\partial \varphi} > 0$. In addition, $\frac{\partial r^D}{\partial \varphi} > 0$. Therefore if

$$-\Phi\beta(1-p) + [1-\beta(1-p)]\tau^{1-\mu} > 0$$

or equivalently:

$$\Phi < \frac{[1-\beta(1-p)]\tau^{1-\mu}}{\beta(1-p)}$$

then $\frac{\partial D}{\partial \varphi}$>0 which implies that among financially-constrained firms with $\varphi \geq \overline{\varphi}^{X,B}$ and $n < \omega f^X$, the more productive the firm is, the more likely it will borrow to export.

The derivative of *D* with respect to *n* is:

$$\frac{\partial D}{\partial n} = -\beta(1-p)\{\pi^D + (1+r_0)n\}\frac{\partial \Phi}{\partial n} - \Phi\beta(1-p)(1+r_0)$$

$$\frac{\partial D}{\partial n}=\frac{\beta(1-p)\{\pi^{D}+(1+r_0)n\}\phi(1+r_0)}{p^X y^X\sigma}-\Phi\beta(1-p)(1+r_0)$$

where ϕ represents the density function of the standard normal distribution.

If $\frac{\Phi}{\phi}<\frac{\{\pi^{D}+(1+r_0)n\}}{p^X y^X\sigma}$, then $\frac{\partial D}{\partial n}>0$

2. Proofs that the default probability is decreasing in firm productivity and liquidity level

3.

Suppose the export income shock z_{it} follows a truncated normal distribution $N(1,\sigma^2)$ which is left-truncated at zero. Using the c.d.f for truncated normal distribution, the probability of default for a borrowing exporter is:

$$\Phi^{\mathrm{X,B}}\equiv \mathrm{Probability}\left(z_{it}\le\frac{(1+r)\omega f^{X}-(1+r_0)n+(\omega\tau * y^X/\varphi)-\pi^D}{p^X y^X}\right)$$

$$=\frac{1}{1-F(-1/\sigma)}\left[F\left[\frac{(1+r)\omega f^{X}-(1+r_0)n+(\omega\tau * y^X/\varphi)-\pi^D-1}{\sigma p^X y^X}\right]-F(-1/\sigma)\right]$$

where F is the c.d.f of the standard normal distribution. Since z_{it} follows a truncated normal distribution $N(1,\sigma^2)$ which is left-truncated at zero:

$$\frac{(1+r)\omega f^{X}-(1+r_0)n+(\omega\tau * y^X/\varphi)-\pi^D}{p^X y^X}>0$$

or

$$(1+r)\omega f^{X}-(1+r_0)n+(\omega\tau * y^X/\varphi)-\pi^D>0$$

Taking derivative of the default probability with respect to firm productivity:

$$\frac{\partial\Phi^{X,B}}{\partial\varphi}=\frac{1}{1-F(-1/\sigma)}\,f\left[\frac{(1+r)\omega f^{X}-(1+r_0)n+(\omega\tau * y^X/\varphi)-\pi^D-1}{\sigma p^X y^X}\right]\frac{\partial B}{\partial\varphi}$$

where f denotes the p.d.f of the standard normal distribution and

$$B = \left[\frac{(1+r)\omega f^{X} - (1+r_0)n + (\omega\tau * y^{X} / \varphi) - \pi^{D} - 1}{\sigma p^{X} y^{X}} \right] = \frac{(1+r)\omega f^{X} - (1+r_0)n - \pi^{D} - 1}{\sigma p^{X} y^{X}} + \frac{(\omega\tau y^{X} / \varphi)}{\sigma y^{X} \frac{\tau\omega}{\rho\varphi}}$$

$$= \frac{(1+r)\omega f^{X} - (1+r_0)n - \pi^{D} - 1}{\sigma p^{X} y^{X}} + \frac{\rho}{\sigma}$$

$$\frac{\partial A}{\partial \varphi} = \frac{(1+r)\omega f^{X} - (1+r_0)n - \pi^{D} - 1}{\sigma} \frac{\partial \left(p^{X} y^{X}\right)^{-1}}{\partial \varphi} + \frac{1}{\sigma p^{X} y^{X}} \left[\omega f^{X} \frac{\partial r}{\partial \varphi} - \frac{\partial \pi^{D}}{\partial \varphi} \right]$$

Since $\frac{\partial \left(p^{X} y^{X}\right)^{-1}}{\partial \varphi} < 0$, $\frac{\partial r}{\partial \varphi} < 0$ and $\frac{\partial \pi^{D}}{\partial \varphi} > 0$, $\frac{\partial B}{\partial \varphi} < 0$ when $(1+r)\omega f^{X} - (1+r_0)n - \pi^{D} - 1 \geq 0$

In other words, the probability of default on loan is decreasing with productivity when $(1+r)\omega f^{X} - (1+r_0)n - \pi^{D} - 1 \geq 0$

Taking derivative of the default probability with respect to firm liquidity:

$$\frac{\partial \Phi^{X,B}}{\partial n} = \frac{1}{1 - F(-1/\sigma)} f \left[\frac{(1+r)\omega f^{X} - (1+r_0)n + (\omega\tau * y^{X} / \varphi) - \pi^{D} - 1}{\sigma p^{X} y^{X}} \right] \left[\omega f^{X} \frac{\partial r}{\partial n} - \frac{1+r_0}{\sigma p^{X} y^{X}} \right]$$

Since $\frac{\partial r}{\partial n}$ <0, $\frac{\partial \Phi^{X,B}}{\partial n} < 0$, which means that the probability of defaulting on loan is decreasing with the firm's liquidity stock.

4. Proof that $E_t\left[I^{X,B}(\varphi^{B}, n) \middle| default \right]$ is increasing in firm productivity and liquidity level

Recall that

$$E_t\left[I^{X,B}(\varphi^{B}, n) \middle| default \right] = \int_{z_{it}^{B,Min}}^{z_{it}^{B,Default}} \left[\pi^{D} + z_{it} p^{X} y^{X} - \frac{\omega\tau * y^{X}}{\mu} + (1+r_0)n \right] l(z) dz$$

where $z_{it}^{B,Default}$ solves:

$$I^{X,B}(z_{it}, \varphi^{B}, n) = \pi^{D} + z_{it} p^{X} y^{X} - \frac{\omega\tau * y^{X}}{\mu} + (1+r_0)n - (1+r_{it})\omega f^{X} = 0$$

and $z_{it}^{B,Min}$ solves:

$$I^{X,B}(z_{it},\varphi^B,n)=\pi^D+z_{it}p^X y^X-\frac{\omega\tau * y^X}{\mu}+(1+r_0)n=0$$

with r_{it} being the interest rate on the loan.

Using Differentiation under the Integral Sign rule:

$$\frac{\partial E_t\left[I^{X,B}(\varphi^B,n)\middle| default\right]}{\partial\varphi}=\int_{z_{it}^{B,Min}}^{z_{it}^{B,Default}}\frac{\partial\left[\pi^D+z_{it}p^X y^X-\frac{\omega\tau * y^X}{\mu}+(1+r_0)n\right]}{\partial\varphi}l(z)dz$$

Thus,

$$\frac{\partial E_t\left[I^{X,B}(\varphi^B,n)\middle| default\right]}{\partial\varphi}>0 \text{ since } \frac{\partial\left[\pi^D+z_{it}p^X y^X-\frac{\omega\tau * y^X}{\mu}+(1+r_0)n\right]}{\partial\varphi}>0$$

Taking derivative of the expected net worth of the firm that the banks can collect in case the firm defaults with respect to firm liquidity level:

$$\frac{\partial E_t\left[I^{X,B}(\varphi^B,n)\middle| default\right]}{\partial n}=\int_{z_{it}^{B,Min}}^{z_{it}^{B,Default}}\frac{\partial\left[\pi^D+z_{it}p^X y^X-\frac{\omega\tau * y^X}{\mu}+(1+r_0)n\right]}{\partial n}l(z)dz$$

$$\frac{\partial E_t\left[I^{X,B}(\varphi^B,n)\middle| default\right]}{\partial n}=\int_{z_{it}^{B,Min}}^{z_{it}^{B,Default}}(1+r_0)l(z)dz$$

Thus, $\frac{\partial E_t\left[I^{X,B}(\varphi^B,n)\middle| default\right]}{\partial n}>0$

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