

**Credit Constraints, Technology Choice and Exports:
A Firm Level Study for Latin American Countries***

Syed Hasan and Ian Sheldon[†]

Abstract

In this paper constraints on technology choice and credit access are introduced into the Melitz (2003) model in a dynamic setting in order to explain the factors that limit the benefits to a firm from trade liberalization. Theoretical analysis shows that firms face credit constraints depending on their initial productivity and the cost of the credit. As a result, credit constrained firms may never be able to cross the minimum productivity threshold needed to enter and compete in a foreign market. Empirical analysis using firm level data for five Latin American countries confirms that firms face credit constraints in technology adoption and the extensive margin of trade.

Keywords: Credit, Innovation, Constraints, Export

JEL classification: F12, F14, F16

* Syed Hasan thanks the Institute of International Education for granting the doctoral scholarship which made this research possible.

[†] Department of Agricultural, Environmental, and Development Economics, The Ohio State University. Correspondence email: hasan.47@osu.edu

Introduction

The use of firm level data has opened new areas of research in international economics. The focus of this new research concerns productivity variation across firms and their decision to produce for domestic or foreign markets. Studies of inter-firm trade data and industry level exports identify some unique features. According to Bernard *et al.* (2007) in 2000, only 4 percent of the 5.5 million firms operating in the US were exporting enterprises and the top 10 percent of these exporting firms accounted for 96 percent of US total exports by value. In more recent work by the same authors, they report that in 2002, only 18 percent of all US manufacturing firms were exporters (Bernard *et al.*, 2012). Other studies, such as that of Clerides *et al.* (1998), show that exporters have higher productivity than non-exporters.

The theoretical explanation for these empirical observations was almost non-existent until a decade ago. Melitz (2003) in a seminal paper developed a model wherein it is only feasible for firms to enter foreign markets if their productivity is above a certain threshold. The underlying idea is that trade liberalization diverts factors of production towards the most productive firms in the market. Exporters, based on their higher productivity, can make enough profits to cover the fixed costs incurred in establishing foreign market operations.

The Melitz model, based on heterogeneous firms under monopolistic competition, assumes identical fixed costs in the production function. Firms use the same production technology but are heterogeneous in their productivity levels supported through a productivity draw from an exogenous distribution. The variation in productivity levels across firms can be gauged from the differences in their marginal costs. This affects a firm's production decision: it either produces for the domestic market only, or it produces for the foreign market as well, or it

exits the industry. In addition, the Melitz model assumes no credit constraints, as firms are unconstrained in their investment decisions regarding fixed costs of market entry.

The realities on the ground in developing countries do not support assumptions about identical firm technology and zero credit constraints. First, firms produce using various types of technologies. Second, firms may require credit to finance acquisition of frontier level technology. Trade liberalization, therefore may not result in diversion of resources towards the most productive enterprises. Although, neoclassical and endogenous growth theories also assume that access to the latest technology automatically follows trade openness (UNCTAD, 2003), however, acquiring world production frontier level technologies requires conscious decisions by firms (UNDP, 2007).

Access to financial credit and new technologies are topics of interest here. Access to financial credit is significant for firms, especially in developing countries where equity markets are underdeveloped. The associated information asymmetries and contract enforcement problems make external credit an imperfect substitute for firm's retained earnings and invalidate the separation between financing and investment choices implied by the Modigliani-Miller (1958) theorem. Firms with limited or no access to credit, therefore, cannot undertake potentially profitable projects without incurring the extra cost of capital. Thus access to new technology is also adversely affected, as firms are constrained in their investment decisions.

There is widespread agreement on the importance of technological progress for economic growth. Technological change increases the productivity of land, labor and capital, reducing costs of production and improving the quality of outputs. The ability to be internationally competitive also depends on having up-to-date technology. Recently many developing countries have undertaken fast and deep trade liberalization, technological progress being vital for their

competitiveness and economic viability. Technological change will aid in reaping the benefits of globalization if it forms part of a broader strategy to improve productive capacities (UNCTAD, 2007).

The decision to make the initial and ongoing investment is contingent on the firm's perception that the future benefits will outweigh the costs involved. The solution to a firm's profit maximization problem subject to technology costs leads to an optimal investment decision in a dynamic two period setting. The research methodology of this paper is based on introducing technology choice and credit constraints simultaneously into the Melitz (2003) model. The Melitz model identifies two categories of fixed costs borne by exporting firms. First there is a market entry cost which controls firm's productivity, and for the present study this component is treated as the production technology cost. Second, there are fixed costs of establishing a foreign market network and obtaining information. The model outlined below considers both these fixed costs in order to identify the investment decision of the firm.

In the current paper, Schmidt's (2010) setup of introducing technology choice in the firm's demand and profit functions is followed with firms being able to opt between low, intermediate and high levels of technology. This decision is constrained by the limitations of the firm's own retained earnings and availability of external credit. The presence of credit constraints limit a firm's technology choice and its opportunities relating to the intensive (trade deepening) or extensive (trade expansion) margins of trade.

The research reported in this paper is significant at two levels. First, at the firm level, arriving at the optimal investment decision is critical for a profit maximizing firm. A firm having already invested in a specific technology knows its productivity and profits. Using these it can decide on optimal investments to upgrade its production technology. Second, at the policy level,

marginal firms can be identified who if supplied with essential credit can cross the productivity threshold and enter foreign markets.

The predictions of the theoretical model are also tested empirically. The data used for this are taken from the World Bank's Enterprise Survey for the years 2006 and 2010. This database provides relevant information regarding the variables in the model. Panel data are used for 1114 firms from Latin America (Argentina, Brazil, Columbia, Chile, Mexico and Venezuela). The econometric results suggest that credit availability is significant for the decision to export, but is not significant in determining the volume of exports. In addition, the empirical results indicate that a firm's decision to invest in capital goods such as plant, machinery and equipment depends on its access to credit. Finally, a firm's investment in capital goods has a positive and significant effect on its export decision.

The major components of the paper are as follows: the literature is reviewed briefly, followed by development of the theoretical model and discussion of the empirical analysis of the associated hypotheses. Finally, the results are presented along with some concluding thoughts.

1. Literature Review

Do all firms trade? No. Based on this oft asked question and evidence from firm-level trade data, Melitz (2003) introduced productivity differences between firms into Krugman's (1980) earlier model of trade in the presence of monopolistic competition. On the demand side, a constant elasticity of substitution (CES) utility function is assumed to allow for differentiated consumption from substitutable varieties of a product. On the supply side, market structure is characterized by monopolistic competition and firm productivity is random. Firms face a constant marginal cost and fixed overhead production cost with a single input (labor) which is

treated as the *numeraire*. Before entry, firms face productivity uncertainty. A firm has to pay a fixed cost of entry and only after that can it obtain its productivity draw from a known distribution. We assume that a firm may experience a positive change in its productivity arising out of R&D investment that produces the technical change and which is not accounted for by the usual inputs (labor, capital, intermediate inputs). After observing its productivity the firm decides whether to produce or exit the market.

The Melitz model does not incorporate a firm's choice of appropriate technology as it assumes the existence of a single production technology. Nevertheless, the model provides an innovative element to represent firm heterogeneity using idiosyncratic productivity of each firm, supported through an exogenous productivity distribution. This heterogeneity is fundamental in modeling the choice between alternative production technologies.

Several theoretical extensions have been introduced into the Melitz model. Notable in the current context are those by Bustos (2011) and Schmidt (2010). Bustos introduced technology choice into a trade model with heterogeneous firms. In her setup, firms with higher productivity earn higher revenues and are the only ones to find it feasible to pay higher fixed costs relating to production and exports. The model is used to study the impact of regional free trade agreements on firm's productivity through technology upgrading financed by increased revenues. Bustos' approach differs from related works, such as that of Bernard *et al.* (2007) who consider productivity as a residual in the production function as a proxy for technology.

Schmidt (2010) has also developed an extension of the Melitz model. She departs from Melitz's assumption of a single production technology common to all firms, and instead allows firms to choose between three alternative technologies. The most basic technology (L) is analogous to the firm's own technological frontier. The other two technologies go beyond the

firm's own technological frontier. Firms deciding to upgrade technology may aim at technology from countries within the world technological frontier (technology M), or from the world leaders in R&D (technology H). The choice of technology affects the firm's exporting behavior. Firms with higher technological status are more likely to pursue an aggressive market strategy.

In another strand of literature relating to financial development and firm's progression in domestic or foreign markets, analysis points towards the adverse impact of financial frictions on growth. Specifically, Rajan and Zingales (1998) show that industries dependent on external finance grow faster in financially developed countries. In addition, there is also a growing literature on the link between credit constraints and trade. For example, Manova (2013) has shown that there is a negative effect of credit constraints on the intensive margin of trade at the industry and country level. Thus firms belonging to sectors that depend on outside financing and having less collateral are the most affected. In an earlier paper Manova *et al.* (2010) have shown that credit constraints have a negative impact on both the intensive and extensive margins of trade and as a result the authors are able to explain zero bilateral exports. Also, analysis of French firm level data by Mayneris (2011) shows that financial constraints have a negative impact on a firm's probability of becoming an exporter but do not affect the quantities exported by the firm. Berman and Hericourt (2010) show that in case of developing and emerging economies, access to finance does have significantly positive effect on the foreign market entry decision of firms, but the enterprise's financial health does not increase the size of exports. Thus it can be concluded that the available empirical evidence on the impact of financial constraints on the intensive margin of trade is mixed (Contessi and Nicola, 2012).

The liquidity constraints added to the Melitz model by Chaney (2005) are linked with productivity heterogeneity as less productive firms cannot enter export markets. The work of

Chaney (2005) and Manova (2013) differs as the latter also models sectoral variation in external finance dependence in order to distinguish between the extensive and intensive margins of trade. However, in both articles, credit constraints on firms' export-related decision making have been studied in a static setting. Credit constraints faced by firms are mainly because of the incompleteness of financial markets.

Besides these findings, there is a notable literature providing evidence of liquidity constraints, specifically showing correlation between a firm's financial condition and its investment decisions, e.g., Stein and Kenneth (1998) and Holmstrom and Tirole (1997). In terms of trade, theoretical work such as Becker and Greenberg (2005) shows that financial development becomes a source of comparative advantage in the presence of credit constraints.

2. Model

Consider two symmetric countries, home h and foreign f . The symmetry ensures that wages are the same in both countries, i.e., firms incur the same marginal cost in any specific industry. The investment decision of firms in country h is conditioned on a firm's decision to produce either for the home market only, or both the home and foreign market (exports) or to increase the volume of its exports. Following Schmidt's (2010) extension to the Melitz model, a technology choice among three alternatives is introduced: L (primitive), M (intermediate), and H (latest). The second extension due to Manova (2013) introduces credit constraints on a firm's decision to invest in technology.

The methodology involves developing a theoretical model with inter-temporal choice. Firms may invest at time t_0 based on their production decision at time t_1 , the only factor of production being labor. As noted above, a three-tier technology choice is adopted where the top

level has the highest initial fixed cost but the lowest marginal cost of production. Based on a firm's initial technology type, associated productivity, fixed and marginal costs of production, and profits for each period are derived. The initial choice of technology is exercised by the firm at time t_0 . Retained earnings and available external credit decide a firm's investment decision and hence its profits at time t_1 . Given this, the investment decision of the firm is modeled, thereby pinning down its relevant credit requirements. A firm's productivity and therefore its feasibility to produce either for the domestic market only or both domestic and foreign markets is thus dependent on the underlying technology of production, subject to its ability to finance this choice.

Taking the technology part first, consider two time periods, t_0 and t_1 . The firm's productivity φ_t^T is indexed on subscript t to indicate the time period and superscript T refers to the technology of production. A firm at time t_0 draws an initial productivity φ_0^T from a distribution $g(\varphi_0^T)$ with support $[0, \infty]$. At the same time, the firm also decides about technology innovation depending on its production decision at time t_1 . Of the possible situations at t_0 , the focus of this study is limited to the following two cases:

- (a) A firm with technology L finds its productivity is just sufficient to survive in the domestic market and it decides to enhance its productivity by investing in technological innovation, and hence trading. This relates to the extensive margin of trade.
- (b) A firm's technology is M and its productivity is such that it can undertake some export activity which can be further enhanced, both in terms of quantities and destinations, by switching to technology H . This relates to the intensive margin of trade.

It is assumed that a firm can commit t_0 profits and the balance of investment is financed through external credit. The cost of the technology upgrade is incurred at time t_0 and the productivity enhancement is achieved at time t_1 .

Model Setup

The basic framework relating to demand, production and the firm's investment decision is as follows.

Demand

As in Dixit-Stiglitz (1977), a representative consumer with CES preferences characterizes the demand-side. The good q is produced over a continuum with total available varieties N , indexed over ω , with the following utility function:

$$U = \left[\int_0^N q(\omega)^\rho d\omega \right]^{\frac{1}{\rho}} \quad (1)$$

The varieties of good q are imperfect substitutes, implying $0 < \rho < 1$ and the elasticity of substitution σ between any two goods is given by $\sigma = 1/(\rho - 1) > 1$.

Technology and Production

As in the Melitz model, firms are heterogeneous, producing substitutable varieties of good q , the market being monopolistically competitive. The Schmidt (2010) setup is used to determine firm's profitability in either the home or foreign market. The choice between the three technology types allows analysis of the impact of technology choice on the extensive and intensive margins of trade. The intermediate technology choice is incorporated to explain the intensive margin of trade.

The firm's technology choices $T=L$, M and H have increasing fixed costs and decreasing marginal costs across these choices. A firm starting with technology L at t_0 may opt for

technology M or H . As the latter requires firms to incur a higher fixed cost, the firm has to invest to benefit from a lower marginal cost of production. Under monopolistic competition each firm faces a residual demand curve and thus charges a markup above the marginal cost of production. Wages are the same for all technology types and are normalized to one - otherwise with low technology, a firm will employ low paid less skilled labor that has low productivity, thereby causing a higher marginal cost of production.

As in Bustos (2011), firms with technology T produce with constant marginal cost $(1/\varphi^T)$ and multiples of fixed cost f . The fixed cost multiple is η_T such that for the three technology options $\eta_H > \eta_M > \eta_L = 1$. The total cost (TC) under each technology irrespective of time period is as follows:

$$TC_T = \eta_T f + \frac{q}{\varphi^T} \quad (2)$$

Firm Entry and Exit Decision

In order to enter an industry a firm first has to incur a technology-specific sunk cost. The firm knows its productivity level only after that. As in the Melitz model, until its productivity is drawn the firm is not aware of whether it will remain in the market or will be forced to exit. So the firms do not know their productivity unless they incur the fixed cost of entering the market. A rational firm at first picks the technology with the lowest fixed cost in order that it incurs minimum losses in case it is forced to exit. According to Aw *et al.* (2007), a firm's productivity is positively related to its technology except that the gains in productivity with more expensive technologies are diminishing in nature. In every period there is a probability δ that a firm is hit by a bad shock and is forced to exit. It is assumed that with technology choice L the productivity level φ^L crosses the threshold level, defined as the zero cutoff productivity level by Melitz

(2003), which is required to make non-negative profits in the home market. For the three technology types the corresponding firm productivity follows the increasing order $\varphi^H > \varphi^M > \varphi^L$ and $\tilde{\varphi}^T$ represents the mean productivity of the group of firms using technology T .

Equilibrium of the Model (Closed and Open Economy)

Firms' profits and productivity associated with technologies L and M are shown in figure 1 drawn in the manner of Helpman *et al.* (2004). The intercepts give the fixed costs associated with each technology and the fixed costs of exporting f_x . Technology L (the most primitive one) has a fixed cost of f and zero-cutoff productivity $\hat{\varphi}^L$ such that any firm with productivity below this is forced to exit. For the marginal firm the productivity cutoff condition is $\pi_h\left(\hat{\varphi}_0^L\right)=0$.

Technology L is the same as the one assumed in the Melitz model. For technology L the mean productivity is $\tilde{\varphi}^L$. The technology specific mean productivity is used to determine the equilibrium conditions.

In the case of technology M , if the firm produces for the home market alone the fixed cost is $\eta_1 f$ ($\eta_1 \in \eta_M$) and if it produces for the foreign market the total fixed cost is $\eta_1 f + f_x$ as shown in figure 1. $\hat{\varphi}^M$ is the zero cutoff productivity level for technology M . For the marginal firm switching from optimal productivity $\tilde{\varphi}^L$ under technology L , the following condition holds:

$$\pi_h\left(\varphi^{M(h)}\right)=\pi_h\left(\tilde{\varphi}^L\right) \quad (3)$$

At this productivity when the firm switches from technology L to technology M and produces for the home country, it can profitably cover the higher fixed cost $\eta_1 f$ and earn higher profits. If the firm also decides to produce for the foreign market meets the condition:

$$\pi_{h+f}(\varphi^{M(h+f)}) = \pi_h(\tilde{\varphi}^L) \quad (4)$$

That is a firm whose productivity with technology L permits it to opt for an investment decision will acquire technology M . Similar equilibrium conditions exist for switching from technology M to technology H . The equilibrium productivity levels for each case can be obtained from equations (3) and (4).

Technology Choice and Investment Decisions by Firms with Technology L

It is assumed that a firm with technology L has productivity that is just feasible for producing for h , i.e., the home market only. In t_0 the firm maximizes the following profit function:

$$\pi_h(\varphi_0^L) = p_h(\varphi_0^L) q_h(\varphi_0^L) - \frac{q_h(\varphi_0^L)}{\varphi_0^L} - f \quad (5)$$

where p_h is the price of product in the home market set as a markup over marginal cost, and q_h is the quantity that a firm produces for the home market. Now let the firm decide on upgrading to either technology M or H , which implies a need for external financing through credit $C(\cdot)$ measured in terms of the *numeraire*. In t_1 firm has to pay back, $R(\cdot)C(\cdot)$, where $R(\cdot) \geq 1$ is the principal plus interest rate charged by the creditor. The credit amount and the rate of interest charged by a financial institution are a function of several factors including a firm's productivity in t_0 , the collateral it can offer, its profit earning trend, and its affiliation with either a domestic or foreign business group and expected profits in t_1 . Due to information asymmetries the

opportunity cost of external financing is greater than internal financing which is normalized to one. By adopting improved technology, a firm will produce for both the home and foreign markets such that it earns positive profits from both in t_1 . However, the firm has to pay the additional trade costs, which includes the fixed cost $f_x > 0$, variable iceberg transport costs and the cost of credit. The firm therefore maximizes the following:

$$\Pi(\varphi_1^{M/H}) = \pi'_f(\varphi_1^{M/H}) + \pi'_h(\varphi_1^{M/H}) - R(.)C(.) \quad (6)$$

where $\pi'_f(\varphi_1^{M/H})$ and $\pi'_h(\varphi_1^{M/H})$ are the present value of firm profits from foreign and home markets respectively with either technology M or H in t_1 ($\pi' = \left(\frac{1}{\delta}\right)\pi$ is discounted future profit).

To determine the profit maximizing credit amount, the first order condition is applied to the above equation with respect to $C(.)$

$$\delta \left\{ \Pi \left(\varphi_1^{\frac{M}{H}} \right) \right\} / \delta \{ C(.) \} = \delta \pi'_f(\varphi_1^{M/H}) / \delta \{ C(.) \} + \delta \pi'_h(\varphi_1^{M/H}) / \delta \{ C(.) \} - \delta [R(.)C(.)] / \delta \{ C(.) \} \quad (7)$$

Simply, this shows that at t_0 the feasible credit should be such that in equilibrium at t_1 a firm's marginal rate of return from the investment is equal to the marginal cost of the credit.

If a firm produces for both the home and foreign markets then the profits are given as:

$$\pi_h(\varphi_1^M) + \pi_f(\varphi_1^M) = \frac{(1 + \tau^{1-\sigma})}{\rho} E(P\rho)^{\sigma-1} (\varphi_1^M)^{\sigma-1} - \eta_M f - f_x \quad (8)$$

Assuming that productivity has a diminishing return to investment and considering that the entire investment is financed by credit, the relationship between the two period productivities and the investment is given by:

$$\varphi_1^{M/H} = \left[C(\varphi_0^L, \cdot) \right]^\alpha \varphi_0^L \quad (9)$$

where $0 < \alpha < 1$. The credit is to acquire higher level technology M or H . Using the relation above, the optimal investment for this case is as follows (see Appendix for derivation):

$$C(\varphi_0^L, \cdot) = (E\alpha)^{\frac{1}{\beta}} \left[\frac{\sigma-1}{\sigma} \right]^{\frac{\sigma}{\beta}} \left[P\varphi_0^L \right]^{\frac{\sigma-1}{\beta}} \left[\frac{\delta}{1+\tau^{1-\sigma}} \right]^{\frac{1}{\beta}} \left[\frac{1}{R(\varphi_0^L, \cdot)} \right]^{\frac{1}{\beta}} \quad (10)$$

where $\beta = 1 - \alpha(\sigma - 1)$.

To ensure that the investment function converges, it is assumed that $\beta \neq 0$.

Some intuition is useful at this point. The firm's investment decision is determined endogenously in the model. The amount of feasible credit used is a decreasing function of its price so the higher the price of credit, the higher will be the level of credit constraint faced by the firm. Also investment financed by credit is positively related to firm's initial productivity such that more productive firms can secure larger loans.

3. Empirical Implementation

In this section the effect of credit availability on the extensive and intensive margins of trade and a firm's decision to invest in plant and machinery is analyzed. Considering the fixed costs as shown in expressions (5) and (8) above, a firm may face credit constraints for either the market entry or export decision or both. The following hypotheses are outlined for testing:

- (i) Extensive Margin of Trade: credit availability increases the likelihood of export by a firm.
- (ii) Intensive Margin of Trade: the volume of exports by a firm is more likely to increase with credit.

- (iii) The likelihood of a firm investing in capital goods (plant, machinery and equipment) increases with access to credit.
- (iv) The likelihood of a firm exporting increases with its investment in capital goods.

Data

The dataset used for this research comes from the World Bank Enterprise Surveys for Latin American countries. The surveys were conducted twice: 2006 and 2010 for Argentina, Bolivia, Colombia, Peru, Mexico and Venezuela. The surveys were carried out in order to identify the technological, contractual and financial constraints faced by firms. The surveys contain detailed quantitative and qualitative questions about firm's access to finance, production, innovation, labor employment and business related infrastructure and market information. The main piece of survey information used in this paper relates to credit access, exports as a percentage of sales and introduction of new production processes or products.

In order to provide some institutional background to the empirical analysis, a country-specific brief on credit availability for firms in Latin America is presented at this point, which is primarily based on Galindo *et al.* (2003). The financial market reforms in the countries selected for the study show varying trends in interest rates as depicted in table 1.

Argentina

Since the turn of the century, credit constraints faced by firms has been a high profile issue. The cost of credit is high and its availability is limited. Financial markets are underdeveloped not only in comparison with developed OECD countries but also neighboring emerging economies such as Chile. Due to the limited options presented by capital markets, bank credit is crucial for firms.

Colombia

Financial reforms in the 1990s decreased liquidity and debt requirements, but credit constraints faced by firms did increase in the 1990s. Only firms belonging to conglomerates and multinationals have been found to be less credit-constrained (Arbelaez and Echavarría, 2002).

Mexico

A significant feature of Mexico is the existence of an internal capital market within each business group. Affiliated firms still have access to financing by using cross financing even though they are rationed out of external capital markets (Castaneda, 2002).

Peru

Beginning in 1990, Peru implemented a market-oriented reform package that included a set of laws expected to boost the development of the capital market. This prompted some Peruvian firms to use the capital market as an additional resource to bank credit in financing their operations. Although, this reform package was promising until 2001, there was very limited long-term financing available, both in the banking system and in the debt market as explained by Choy (2002).

Venezuela

Haggerty (1990) shows that capital markets that constituted a major component of the private financial system were slow to develop and remained quite weak in 1990s. A possible explanation for the slow growth in capital markets was the traditional, family nature of businesses in Venezuela and the lopsided distribution of income, which limited the savings or capital accumulation of the lower classes. Investors were also skeptical of inadequate government regulation of publicly traded stocks and the state's history of intervention in industry.

A comparison of tables 2 and 3 based on data for the period 2006 to 2010 confirms that the number of firms reporting high interest rates as a reason for not applying for credit was rising in Argentina and falling in Peru. The evidence presented in the tables also shows that many Mexican firms do not have a bank account of their own, which confirms the presence of an informal channel of financing.

Sample Selection

The industry selection in the dataset is broad based and firm selection is random to ensure that they are true representatives of the population. The degree of heterogeneity in the sample reduces as the firms share the following: they are small or medium in size, privately owned urban-based and relate to the manufacturing sector. However, to account for time-invariant firm-specific unobservable characteristics, dummy variables are used in the model. The country and industry wise descriptive statistics of the firms are given in tables 4 and 5.

Variables of Interest

Dependent Variable

To examine the effect of credit availability on export and investment decisions made firms, three dependent variables are defined: first *Export* is equal to 1 if the firm undertakes direct exports and zero otherwise; second, *ExportShare* is defined as the logarithm of the direct exports share of the total sales of an exporting firm; third, *Invest* is defined as being equal to 1 if a firm invests in plant, machinery and equipment, and zero otherwise.

Credit Availability Variable

The variable central to this study is *Credit* which equals 1 if a firm has an outside line of credit from a private commercial bank or a financial institution and zero otherwise.

Control Variables

To control for several firm characteristics, the logarithm of the number of the production and support labor employees are used as shown in figure 2. In addition, a firm's affiliation with a business group or foreign investment in its stocks is depicted by a binary variable *Conglo*.

Dummy Variables

To capture the effect of unobservable characteristics, dummy variables based on a firm's location (6 countries) and industry (19 categories) have been used.

Empirical Methodology

The theoretical model outlined suggests that credit constraints negatively affect a firm's investment decision to invest in new technology and pay off the fixed costs of entering a foreign market.

Hypothesis (i) deals with a binary discrete choice which depends on whether the firm is exporting or not; specifically the following probit model is used to test the probability of export by firm i :

$$prob(Export = 1) = prob(\alpha + \beta Credit_i + \kappa Z_i + \mu_i > 0) = \Phi(\alpha + \beta Credit_i + \kappa Z_i) \quad (11)$$

where Z are the control variables. The error term μ_i has a standard normal distribution relating to unobserved firm attributes and other unaccounted factors that may influence the dependent variable. The expected sign of the *Credit* coefficient is positive, that is $\beta > 0$.

For hypothesis (ii), the dependent variable in (11) is replaced with the logarithm of direct export share in total sales as follows:

$$ExportShare = \alpha + \xi Credit_i + \kappa Z_i + \varepsilon_i \quad (12)$$

As only exporting firms are being considered, the export share is always greater than zero. The expected direction of the *Credit* coefficient based on the available literature is ambiguous as this parameter determines the significance of the fixed or marginal costs of trading.

For hypothesis (iii), the reported access to credit is regressed on a firm's decision to invest in plant, machinery and equipment, using the following probit model:

$$prob(Invest = 1) = prob(\alpha + \beta Credit_i + \kappa Z_i + \mu_i > 0) \quad (13)$$

where μ_i is normally distributed random error term.

Hypothesis (iv), tests the likelihood of export increases with the firm's investment in capital goods:

$$prob(Export = 1) = prob(\alpha + \beta Invest_i + \kappa Z_i + \mu_i > 0) \quad (14)$$

Exogeneity Test and Instruments

Establishing a causal relation between either a firm's export and credit availability or a firm's investment in technology and credit availability is likely to suffer from endogeneity. Two plausible scenarios for this are described here. First, firms with high productivity and large exports earn higher profits and are more likely to have easy access to a supply of credit. Second, inefficient firms while answering the survey question may report problematic access to finance in order to cover up their poor performance (Beck *et al.*, 2005).

For hypothesis (i), the Smith-Blundell (1986) test is used to confirm exogeneity of the *Credit* variable. Rejection of the null hypothesis at the 5 percent significance level implies that the *Credit* variable is endogenous. Consequently, an instrumental variables (IV) approach is used, and the Durbin-Wu-Hausman (1973) test of endogeneity is applied. Using the IV approach with a panel regression, resolves the endogeneity issue. In the case of hypothesis (ii), the Durbin-Wu-Hausman (1973) test of endogeneity shows the *Credit* variable is endogenous, however,

based on using an Instrumental Variable Two Stage Least Squares (IV/2SLS) panel regression, exogeneity is confirmed through the Davidson-Mackinnon test (1993).

In the case of hypothesis (iii), reverse causality is very likely. A firm investing in capital goods is more likely to have access to external finance from banks compared with one which does not purchase these items. The identified instruments are used to test the validity of the hypothesis.

Robustness Checks-Instrumental Variables Approach

To handle the endogeneity problem further analysis is based on an IV/2SLS approach. One of the instruments selected for this is *OverDraft* which equals 1 if a firm enjoys an overdraft facility and zero otherwise. An overdraft line of credit arising from an agreement between a firm and a bank is based on an evaluation of its credit worthiness. This type of finance is usually short term, with a limited amount and a higher interest rate as compared to a regular loan. The second instrument is *ExtFin* which equals 1 if financing for the fixed assets of a firm is borrowed from a private bank and zero otherwise. For hypothesis (iii) besides *OverDraft*, another instrument used is *FinInd* which reflects whether a firm had its financial statements audited independently or otherwise. The requirement for an independent audit is usually imposed by a regulator and is not correlated with the export status of a firm.

As there are two instruments for one endogenous variable in each model, the over-identification restrictions can be checked using Sargan's (1958) test. For each model the test statistics show that the instrumental variables are uncorrelated to the residuals and are therefore valid.

Regression Results

The results of the 2SLS analysis of hypothesis (i) are given in columns (1) and (2) of table 6. The coefficients show the marginal values for the pooled and panel models. The impact of credit availability on a firm's decision to export is positive and statistically significant.

Similar results are obtained with the base probit models. As unobservable factors and the endogeneity of the credit variable are not considered in these models, the results are not reported here. As noted above, the problem of credit endogeneity is addressed by employing an IV/2SLS procedure. The IV model is estimated with a full set of industry and city dummies to capture the country-industry fixed effects, the results are shown in column (1). Finally IV estimation for panel regression with fixed effects is used (column 2). The time invariant unobserved effects can be controlled by performing a random effects model on the panel of firms assuming the firm specific error term, is uncorrelated with the included variables. However, as explained in Arulampalam (1996) the random effects probit coefficients could be misleading as the covariance matrix of standard errors could be biased. Also as the appropriateness of the random effects estimators is not established by the Hausman specification test, they are not reported.

For hypothesis (ii) which allows a test relating to the intensive margin of trade, the dependent variable is defined as the logarithm of share of direct exports in the total sales of the firm. This is regressed against the same explanatory and control variables as in hypothesis (i). Columns (3) and (4) of table 6 show the results for the fixed effects 2SLS model for pooled and panel data. The credit variable has a negative coefficient, although it is statistically significant only in column (3) for the IV/2SLS model. The negative relation indicates that credit availability in the economy causes diversion of resources towards more productive but financially vulnerable sectors and thus the intensive margin of trade of firms already in the export market gets shallow.

It can be concluded that once a firm has incurred the fixed costs of production and entry to foreign markets, they are not credit constrained to increase the volume of their exports. Controlling for the time invariant fixed effects using panel regression removes the statistical significance.

Hypothesis (iii) is used to test the significance of credit in a firm's investment decision concerning plant, machinery and equipment procurement. The results are shown in columns (5) and (6) of table 6. Irrespective of the model, credit is always highly statistically significant in a firm's investment decision. The results were obtained after controlling for endogeneity and fixed effects with standard errors clustered on the type of industry. The coefficient of the credit variable indicates its statistical significance in investments made by a firm.

Hypothesis (iv) is defined to test how investment in capital goods is likely to affect the export decision of a firm. The results shown in table 7 indicate that after controlling for endogeneity through instrumental variables, the effect of investment is positive and statistically significant for both the pooled and panel estimates. Thus the main theoretical finding that investment in plant, machinery and equipment is vital for foreign market participation is upheld.¹

4. Summary and Conclusions

The selection of firms in export markets depends on their exogenously determined productivity according to the Melitz (2003) model. However, it is also important to examine the underlying assumptions of this popular model to determine the actual selection of firms in export markets, especially in a developing country context. In the model, financing is required to cover the fixed costs of entering and surviving in foreign markets. The premise of the research reported in this

¹ The results obtained following IV/2SLS regression may suffer from heteroskedasticity. To confirm their validity, semi-parametric maximum likelihood estimation by Klein and Spady (1993) was used. The results confirm that even controlling for heteroskedasticity, statistical significance is maintained.

paper was to find out if credit is significant for firms seeking to undertake direct exports and for investing in plant machinery and equipment.

The Melitz model shows that following trade liberalization there is an intra-industry reallocation of resources, whereby the most productive firms experience growth and the least productive firms are forced to exit. The extant research shows that firms can influence their position in the random productivity draw by investing in R&D and undergoing technical change. Such an investment decision is however constrained by the level of the development of financial markets and ease of access to credit. In the case of developing countries, financial markets are either non-existent or incomplete such that firms have access to limited amounts of credit which often come attached with a high price tag. Firms, therefore, need to assess the feasibility of external borrowing before they decide to invest in R&D or capital goods. The theoretical model developed in this paper considers three different technological choices where, as firms move towards the frontier, the fixed cost component increases but the marginal cost component decreases. Apart from the exogenous probability of exit, there is no other uncertainty, firms being able to assess the profitability of the investment decisions.

The theoretical and empirical results suggest that firms need credit either to undertake innovation in their production, or to introduce significantly improved new products or to meet the fixed cost of entering foreign market. The empirical findings for firms in Latin America further indicate that firms are credit constrained only to the extent of the impact on the extensive margin of trade. The results show that access to credit has no significant impact on the volume of exports. Also credit is positive and significant for capital (plant and machinery) investment decision. Finally the empirical results confirm the main hypothesis of this paper; firms investing in plant and machinery are more likely to enter the foreign markets. All of these results lead to

the conclusion that firms need finance beyond their retained earnings to meet the fixed costs that have to be incurred in order to enter a foreign market and establish an export network.

Viewing these results in the context of global trade liberalization involving developed and developing partners, it can be asserted that the incompleteness or imperfection of financial markets in developing countries acts as domestic restriction on exports which results in net social loss. Firms unable to acquire frontier-level technologies have a mean productivity level that is always below the cutoff threshold necessary to enter the foreign market. When aggregated, this results in a lack of industry level competitiveness and ultimately the country is not able to secure its share in international markets. Such non-tariff barriers to trade need to be the focus of policy design to provide a level playing field for everyone. Potential exporters can be identified on the basis of their initial productivity which if provided with the requisite financing can cross the productivity required for foreign market entry. Extending credit to such firms for introducing innovations or establishing foreign market network can feasibly replace the trade related subsidies to existing exporters.

A final note to this study is to point out that recent theories of firms and trade have the potential to fill the gap in the hitherto theoretical models of free trade and observed trade patterns. Generally, trade discussions focus on barriers and restrictions affecting cross-country trade patterns. However, there are significant firm-level constraints arising out of home country's institutional strength which finally decide the pattern of its exports and the direction of trade. Thus even in cross-country trade, the winners and losers are decided at the firm level and therefore the focus of policy analysis should be at the same level.

Appendix

Firm pricing rule in home market: $p_h = 1 / \rho\varphi$

Firm pricing rule in foreign market: $p_f = \tau / \rho\varphi$

Firm profits from home market: $\pi_h(\varphi_1^T) = \left(\frac{E}{\sigma}\right)(P\rho\varphi)^{(\sigma-1)} - f$ (from Melitz, 2003)

Firm profits from home and foreign markets:

$$\pi_h(\varphi_1^T) + \pi_f(\varphi_1^T) = (1 + \tau^{1-\sigma}) \left(\frac{R}{\sigma}\right) (P\rho\varphi)^{(\sigma-1)} - \eta f - f_x$$

E=aggregate expenditure and P= aggregate price

Now we have $\varphi_1 = [C(\varphi_0, \cdot)]^\alpha \varphi_0$ so

$$\begin{aligned} \delta \left\{ \Pi \left(\varphi_1^{\frac{M}{H}} \right) \right\} / \delta \left\{ C(\varphi_0^L, \cdot) \right\} &= \delta \pi_f(\varphi_1^{M/H}) / \delta \left\{ C(\varphi_0^L, \cdot) \right\} + \delta \pi_h(\varphi_1^{M/H}) / \delta \left\{ C(\varphi_0^L) \right\} - \delta [R(\varphi_0^L) C(\varphi_0^L)] \\ / \delta \left\{ C(\varphi_0^L, \cdot) \right\} &= 0 \end{aligned}$$

$$E \left[\frac{P\varphi_0}{\tau} \right]^{\sigma-1} \alpha \left[(\sigma-1) / \sigma \right]^{1-\sigma} [I\varphi_0]^{-\beta} = p_I E(\varphi_0)$$

$$C(\varphi_0^T, \cdot) = (E\alpha)^{\frac{1}{\beta}} \left[\frac{\sigma-1}{\sigma} \right]^{\frac{\sigma}{\beta}} [P\varphi_0^T]^{\frac{\sigma-1}{\beta}} \left[\frac{1}{1+\tau^{1-\sigma}} \right]^{\frac{1}{\beta}} \left[\frac{1}{E(\varphi_0^T)} \right]^{\frac{1}{\beta}}$$

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Table 1: Average Interest Rates

Country	Interest Rates	
	2006	2010
Argentina	7.63	9
Bolivia	3.57	0.86
Chile	5.25	3.25
Colombia	7.25	3
Mexico	7	4.5
Peru	4.5	3

Source: tradingeconomics.com

Table 2: Reasons Firms Did Not Apply For Credit

Country	No Need / Sufficient Capital	Application Procedure Complex	High Interest Rate		Collateral Required	Total Firms Reporting
			2006	2010		
Argentina	218	45	44	62	29	460
Bolivia	129	10	14	9	16	204
Chile	162	14	0	8	3	225
Colombia	126	7	8	11	6	203
Mexico	228	18	17	13	14	315
Peru	69	6	11	8	6	110

Source: World Bank Enterprise Surveys (2007, 2012)

Table 3: Firm Financial Characteristics

Country	Total Reporting Firms	Firms Bank Account	Firms with Over Draft	Firms with Credit	Firms Credit from Commercial Bank	Firms Credit State Owned Bank	Firms Credit from Other Sources
Argentina	786	775	591	389	313	68	8
Bolivia	358	341	172	195	175	3	17
Chile	550	535	479	420	409	9	2
Colombia	554	548	500	410	386	7	17
Mexico	420	255	90	141	137	1	3
Peru	334	316	239	260	254	0	6

Source: World Bank Enterprise Surveys (2007, 2012)

Table 4: Countries and Share in Sample

Country	Freq.	Percent
Argentina	594	29.2
Bolivia	132	6.49
Chile	388	19.08
Colombia	368	18.09
Mexico	314	15.44
Peru	238	11.70
Total	2034	100

Source: World Bank Enterprise Surveys (2007, 2012)

Table 5: Firm-Industry Statistics

Industry	No of Firms.	Percent
Food	502	24.68
Textiles	236	11.6
Garments	334	16.32
Chemicals	350	17.21
Plastics & rubber	46	2.26
Non-metallic products	62	3.05
Basic metals	6	0.29
Fabricated Metal products	126	6.19
Machinery and equipment	174	8.55
Electronics	50	2.46
Others	148	7.28
Total	2034	100

Source: World Bank Enterprise Surveys (2007, 2012)

Table 6: Regression Results for Hypothesis (i)-(iii)

VARIABLES	(1)	(2)	(3)	(4)	(5)	(6)
<i>Credit</i>	0.273*** (0.055)	0.192* (0.105)	-1.80** (0.422)	-0.420 (0.28)	0.353*** (0.129)	0.685*** (0.224)
<i>Skilled Labor (prod)</i>	0.050*** (0.010)	0.010 (0.014)	0.183** (0.061)	-0.0019 (0.098)	0.037*** (0.014)	0.031 (0.022)
<i>Support Staff</i>	0.057*** (0.017)	0.019 (0.022)	-0.058 (0.105)	-0.067 (0.161)	0.037* (0.014)	0.016 (0.039)
<i>Conglo</i>	0.064* (0.036)	0.013 (0.038)	-0.054 (0.120)	-0.208* (0.070)	0.065 (0.043)	0.018 (0.059)
Observations	1733	1733	591	591	1933	1933
R-squared	0.205	0.012	0.08	0.056	0.148	0.16
Country /Ind FE	Yes	Yes	Yes	Yes	Yes	Yes
Sargan Stat (P-val)	0.514	0.15	0.674	0.464	0.18	0.334

Notes: *Significant at 10% level, **significant at 5% level, and *** significant at 1% level

Table 7: Regression Results-Hypothesis (iv)

MODEL	Pooled IV/2SLS	Panel XTIV
<i>Invest</i>	0.0543*** (-0.0172)	0.144** (-0.0645)
<i>Labemp</i>	0.0789*** (-0.0179)	-0.0749 (-0.0664)
<i>Conglo</i>	0.0942*** (-0.0365)	-0.0401 (-0.0553)
Observations	1,253	788
R-squared	0.043	0.281
Sargan Test Stat.	0.646	0.152

Notes: * Significant at 10% level, **significant at 5% level, and *** significant at 1% level

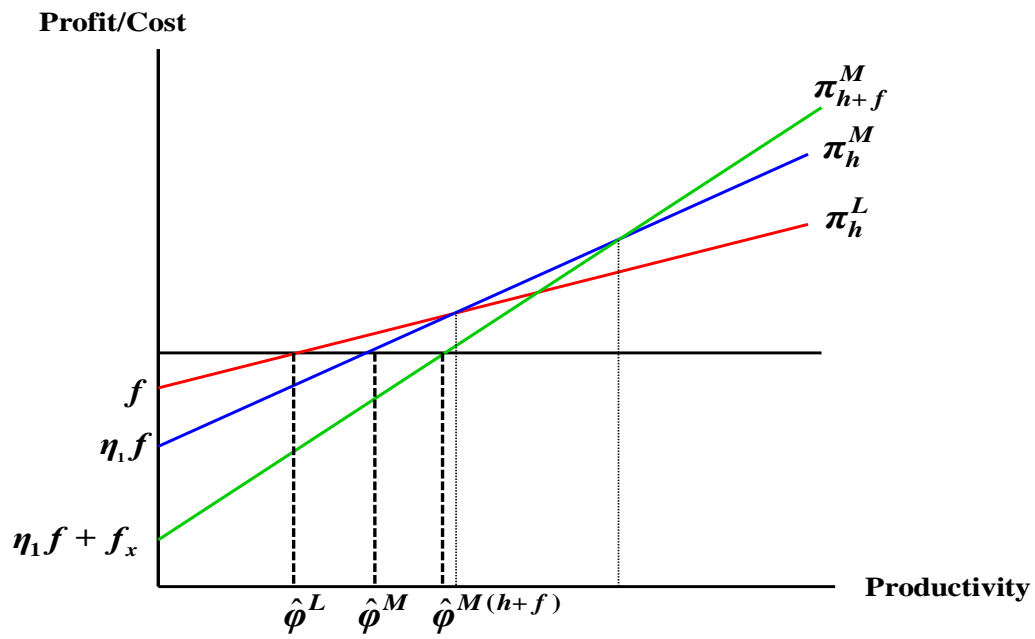
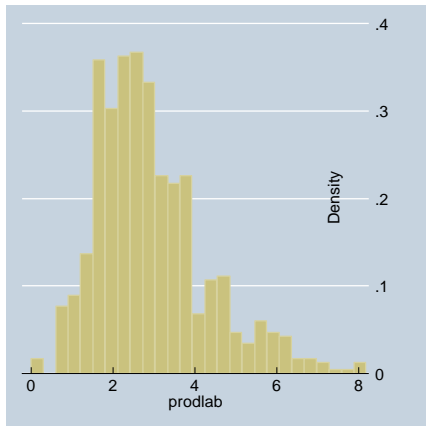
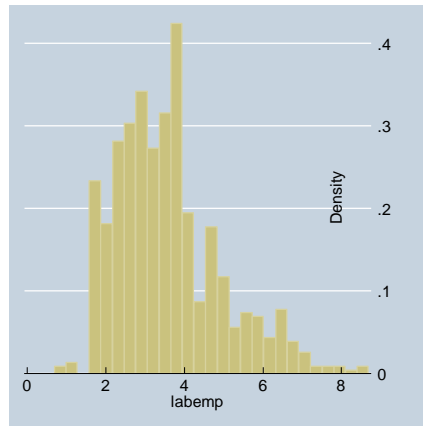


Figure 1: Profits and Productivity level for Firm



(a)



(b)

Source: World Bank Enterprise Surveys (2007, 2012)

Figure 2: Histograms for Control Variables (a) Production Labor (b) Support Labor using