Three Essays on Export and Productivity-Impact of Financial Constraints and Technological Innovation

DISSERTATION

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Abstract

This research, which is divided into three essays, is designed to demonstrate the impact of (a) financial constraints on the investment and export decisions of firms, (b) level of technological intensity of production process and utilization of public incentives such as science parks and (c) the importance of monetary policy reform in securing the benefits of trade reforms. The first essay investigates the impact of technology upgrade on idiosyncratic productivity and choice of production market by firms. The second essay focuses on efficiency of public policy instruments aimed at correcting technology market failure and to check if such support leads to an efficient outcome. The third essay analyzes the impact of opening up an economy on domestic financial growth under constraints imposed by monetary policy. The empirical analyses use either microeconomic firm-level or macroeconomic country-level data.

Theoretical and empirical analysis confirms that firms face financial constraints while making technology upgrade decisions. The extent of the constraints depends on firms’ initial productivity and the cost of credit. As a result, credit-constrained firms may not be able to cross the minimum productivity threshold required to enter and survive in a foreign market. Empirical analysis using firm level data for six Latin American countries confirms the hypothesis that firms face credit constraints in technology adoption and the extensive margin of trade.
Empirical estimation shows that the most efficient utilization of incentives such as science parks is by firms located therein and employing the highest proportion of the high tech oriented workforce. As this proportion falls the productivity distribution of science park firms also moves to the left. Analysis done at the three digit NAICS level shows that efficient utilization of incentives such as science park incentives need to be industry-specific to cause positive productivity improvements, otherwise such policy instruments may end up only as life support for less efficient enterprises.

At the macro level financial constraints imposed by monetary policy have an overwhelming effect on growth of the domestic financial sector. Thus the reallocation of resources towards the most productive units of the economy following trade liberalization is not achieved unless the degree of credit constraints is significantly relaxed. Results show that the volume of domestic credit made available to the private sector depends on the cost of credit that is the interest rate.
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Overview

This dissertation consists of three essays. All three essays are developed around the idea of firm level heterogeneity as presented in the seminal work of Melitz (2003). Using this framework individual firm level heterogeneity is represented by their idiosyncratic productivity. Melitz deals with an individual firm’s productivity draw in a rather abstract manner, and he does not elaborate on the determinants of that productivity draw. This approach has resulted in creating opportunities for further research, while providing the researcher with a robust theoretical model. Taking advantage of this, we develop three essays which help in explaining the impact of financial constraints and technological innovation on firms’ productivity. The regions selected for empirical estimation can be broadly categorized as developing or emerging economies. Although the theoretical models are mainly micro-level we have used both microeconomic and macroeconomic data to test the hypotheses set up in this dissertation.

The first essay concerns credit constraints in investment and export decisions faced by heterogeneous firms in developing countries. In order to make a feasible decision to enter foreign markets, a firm's productivity has to be above a certain threshold level. As financial markets are not perfect in developing countries, firms face credit constraints in acquisition of the latest production technology, and also to meet the foreign market specific costs are incurred before they can begin to export. The theoretical model
identifies the extent of credit constraints. The empirical evidence gathered from Latin America confirms the significance of external financing as firms with access to credit are more likely to export and invest in plant and equipment.

The second essay studies the impact of agglomeration and selection on firms' total factor productivity (TFP) distributions depending on their spatial location, specifically in science parks and large cities in Taiwan. The TFP distributions indicate a mean-shift and greater dispersion whenever firms benefit from agglomeration economies. However, selection due to competition may cause left truncation of the distribution. The empirical analysis shows that in aggregate firms located in science parks have productivity that lags compared to those located in large cities and they benefit mainly from localization externalities. However, when the analysis is made at the three digit NAICS level, the results indicate that the region based productivity distribution depends on the technology intensity of the production process. Thus firms located in science parks and employing the highest percentage of the technical workforce, such as those providing scientific and technical services, have the highest level of productivity.

The third essay analyzes the impact of trade liberalization on the growth of the financial sector in the countries located in sub-Saharan Africa. In this essay we use country level macro data to determine the impact of opening up of the economy on allocative efficiency. The idea is that trade liberalization introduces greater efficiency in the economy and hence improves the profitability of the surviving firms. This increase in the profitability of existing and prospective exporters makes such firms a financially feasible investment venture. It is therefore expected that with trade liberalization the
domestic financial sector may experience growth. The results, however, show that as long as monetary policy is not reformed to reduce the cost of credit, the anticipated benefits of trade cannot be taken advantage of. We use robustness checks for endogeneity and autocorrelation issues which are often associated with macro level data. The econometric estimates confirm that trade liberalization diverts resources to more productive units and leads to growth of the financial sector.
1. 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. While neoclassical and endogenous growth theories also assume that access to the latest technology automatically follows trade openness (UNCTAD, 2003), 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 essay is based on introducing technology choice and credit constraints simultaneously into the Melitz 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 of these fixed costs in order to identify the investment decision of the firm.

In the current essay, 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 essay 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 for the years 2006 and 2010 taken from the World Bank's Enterprise Survey (2012). This database provides relevant information regarding the variables in the model. Panel data are used for 1017 firms from Latin America (Argentina, Bolivia, Columbia, Mexico, Peru 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 essay 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.

2. 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 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 a significantly positive effect on the foreign market entry decision of firms, but the firm'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 and Manova differ 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., Holmstrom and Tirole (1997), and Stein and Kenneth (1998). 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.

3. 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 (2003) 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 $\phi_t^T$ 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 $\phi_0^T$ from a distribution $g(\phi_0^T)$ 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 and 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 $\omega$, with the following utility function:

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

(1)

The varieties of good $q$ are imperfect substitutes, implying $0 < \rho < 1$ and the elasticity of substitution $\sigma$ 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 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 $\left(1/\varphi^T\right)$ and multiples of fixed cost $f$. The fixed cost multiple is $\eta_T$ 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:

$$TC_T = \eta_T f + \frac{q}{\varphi^T}$$  \hspace{1cm} (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. Therefore, 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 \( \delta \) 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 \( \phi^L \) crosses the threshold level, defined as the zero cutoff productivity level by Melitz, 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 \( \phi^H > \phi^M > \phi^L \) and \( \zeta \) 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 1.1 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 \( f^L \) and zero-cutoff productivity \( \phi^L \) such that any firm with productivity below this is forced to exit. For the marginal firm, the productivity
cutoff condition is $\pi_h(\phi_0^L) = 0$. Technology $L$ is the same as the one assumed in the Melitz model. For technology $L$ the mean productivity is $\bar{\zeta}$. 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 $\eta_h f$ ($\eta_h \in \eta_M$) and if it produces for the foreign market the total fixed cost is $\eta_h f + f_x$ as shown in figure 1.1. $\phi^M$ is the zero cutoff productivity level for technology $M$. For the marginal firm switching from optimal productivity $\bar{\zeta}$ under technology $L$, the following condition holds:

$$\pi_h(\phi^M_h) = \pi_h(\bar{\zeta}) \quad (3)$$

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 $\eta_h f$ and earn higher profits. If the firm also decides to produce for the foreign market meets the condition:

$$\pi_{h+f}(\phi^{M(h+f)}_h) = \pi_h(\bar{\zeta}) \quad (4)$$

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:

\[
\pi_h(\varphi_0^L) = p_h(\varphi_0^L)q_h(\varphi_0^L) - \frac{q_h(\varphi_0^L)}{\varphi_0^L} - f
\]  

(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 \( C(.) \) measured in terms of the numeraire. In \( t_1 \) firm has to pay back, \( R(.)C(.) \), where \( R(.) \geq 1 \) 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 \( f_c > 0 \), variable iceberg transport costs and the cost of credit. The firm therefore maximizes the following:

\[
\Pi(\varphi_1^{M/H}) = \pi_f'(\varphi_1^{M/H}) + \pi_h'(\varphi_1^{M/H}) - R(.)C(.)
\]  

(6)
where \( \pi'_{f}(\phi^{M/H}_{1}) \) and \( \pi'_{h}(\phi^{M/H}_{1}) \) 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 \( C(.) \):

\[
\delta \left\{ \Pi \left( \frac{M}{\phi^{H}_{i}} \right) \right\} / \delta \{ C(.) \} = \delta \pi'_{f} / \delta \{ C(.) \} + \delta \pi'_{h} / \delta \{ C(.) \} - \delta [R(.)C(.) / \delta \{ C(.) \}] = 0 \quad (7)
\]

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:

\[
\pi_{k}(\phi^{M}_{1}) + \pi_{f}(\phi^{M}_{1}) = \frac{(1 + \tau_{1}^{1-\sigma})}{\rho} E(\rho) \sigma_{1} \frac{E(\rho) \sigma_{1}}{\sigma_{1}} - \eta_{M} f - f_{x} \quad (8)
\]

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:

\[
\phi^{M/H}_{1} = \left[ C(\phi^{L}_{0}, .) \right]^{\alpha} \phi^{L}_{0} \quad (9)
\]

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-A for derivation):
\[ C(\varphi^t_0, \ldots) = (E\alpha)^{\frac{1}{\beta}} \left[ \frac{\sigma - 1}{\sigma} \right]^\frac{\rho}{\beta} \left[ P\varphi^t_0 \right]^\frac{\sigma - 1}{\beta} \left[ \frac{\delta}{1 + e^{\frac{\rho}{\beta}}} \right]^\frac{1}{\beta} \left[ \frac{1}{R(\varphi^t_0)} \right]^\frac{1}{\beta} \] (10)

where \( \beta = 1 - \alpha(\sigma - 1) \) is used to simplify the expression. 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 the firm's initial productivity such that more productive firms can secure larger loans.

4. 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 are 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.

**Hypotheses**

The following hypotheses are outlined for testing:

(i) **Hypothesis 1**: Extensive Margin of Trade: credit availability increases the likelihood of export by a firm.

(ii) **Hypothesis 2**: Intensive Margin of Trade: the volume of exports by a firm is more likely to increase with credit.

(iii) **Hypothesis 3**: The likelihood of a firm investing in capital goods (plant, machinery and equipment) increases with access to credit.
(iv) **Hypothesis 4**: 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 essay 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 and Schiantarelli (2003). The financial market reforms in the countries selected for the study show varying trends in interest rates as depicted in table 1.1.

**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 Echavarria, 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 1.2 and 1.3 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 1.4 and 1.5.

**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, \( \text{Export} \) is equal to 1 if the firm undertakes direct exports and zero otherwise; second, \( \text{ExportShare} \) 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. 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 \( i \):

\[
\text{prob}(\text{Export} = 1) = \text{prob}(\alpha + \beta C_{i} + \kappa Z_{i} + \mu > 0) = \Phi(\alpha + \beta C_{i} + \kappa Z_{i})
\]  

(11)
where $Z$ are the control variables. The error term $\mu_i$ 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:

$$ExportShare = \alpha + \xi \text{Credit}_i + \kappa Z_i + \epsilon_i$$  \hspace{1cm} (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:

$$\text{prob}(\text{Invest} = 1) = \text{prob}(\alpha + \beta \text{Credit}_i + \kappa Z_i + \mu_i > 0)$$  \hspace{1cm} (13)

where $\mu_i$ is normally distributed random error term.

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

$$\text{prob}(\text{Export} = 1) = \text{prob}(\alpha + \beta \text{Invest}_i + \kappa Z_i + \mu_i > 0)$$  \hspace{1cm} (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 1.6. 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 1.6, 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 1.6. 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 1.7 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

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

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.
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 essay 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 essay; 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
time 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 essay 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.
6. Figures and Tables

![Graph showing profits and productivity](image-url)

Figure 1.1: Profits and Productivity
<table>
<thead>
<tr>
<th>Country</th>
<th>Interest Rates</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>2006</td>
</tr>
<tr>
<td>Argentina</td>
<td>7.63</td>
</tr>
<tr>
<td>Bolivia</td>
<td>3.57</td>
</tr>
<tr>
<td>Chile</td>
<td>5.25</td>
</tr>
<tr>
<td>Colombia</td>
<td>7.25</td>
</tr>
<tr>
<td>Mexico</td>
<td>7</td>
</tr>
<tr>
<td>Peru</td>
<td>4.5</td>
</tr>
</tbody>
</table>

Source: tradingeconomics.com
<table>
<thead>
<tr>
<th>Country</th>
<th>No Need / Sufficient Capital</th>
<th>Application Procedure Complex</th>
<th>High Interest Rate</th>
<th>Collateral Required</th>
<th>Total Firms</th>
</tr>
</thead>
<tbody>
<tr>
<td>Argentina</td>
<td>218</td>
<td>45</td>
<td>44</td>
<td>62</td>
<td>29</td>
</tr>
<tr>
<td>Bolivia</td>
<td>129</td>
<td>10</td>
<td>14</td>
<td>9</td>
<td>16</td>
</tr>
<tr>
<td>Chile</td>
<td>162</td>
<td>14</td>
<td>0</td>
<td>8</td>
<td>3</td>
</tr>
<tr>
<td>Colombia</td>
<td>126</td>
<td>7</td>
<td>8</td>
<td>11</td>
<td>6</td>
</tr>
<tr>
<td>Mexico</td>
<td>228</td>
<td>18</td>
<td>17</td>
<td>13</td>
<td>14</td>
</tr>
<tr>
<td>Peru</td>
<td>69</td>
<td>6</td>
<td>11</td>
<td>8</td>
<td>6</td>
</tr>
</tbody>
</table>

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

Table 1.4: Country-wise Share in the Sample

<table>
<thead>
<tr>
<th>Country</th>
<th>Freq.</th>
<th>Percent</th>
</tr>
</thead>
<tbody>
<tr>
<td>Argentina</td>
<td>594</td>
<td>29.2</td>
</tr>
<tr>
<td>Bolivia</td>
<td>132</td>
<td>6.49</td>
</tr>
<tr>
<td>Chile</td>
<td>388</td>
<td>19.08</td>
</tr>
<tr>
<td>Colombia</td>
<td>368</td>
<td>18.09</td>
</tr>
<tr>
<td>Mexico</td>
<td>314</td>
<td>15.44</td>
</tr>
<tr>
<td>Peru</td>
<td>238</td>
<td>11.70</td>
</tr>
<tr>
<td>Total</td>
<td>2034</td>
<td>100</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Industry</th>
<th>No of Firms</th>
<th>Percent</th>
</tr>
</thead>
<tbody>
<tr>
<td>Food</td>
<td>502</td>
<td>24.68</td>
</tr>
<tr>
<td>Textiles</td>
<td>236</td>
<td>11.6</td>
</tr>
<tr>
<td>Garments</td>
<td>334</td>
<td>16.32</td>
</tr>
<tr>
<td>Chemicals</td>
<td>350</td>
<td>17.21</td>
</tr>
<tr>
<td>Plastics &amp; rubber</td>
<td>46</td>
<td>2.26</td>
</tr>
<tr>
<td>Non-metallic products</td>
<td>62</td>
<td>3.05</td>
</tr>
<tr>
<td>Basic metals</td>
<td>6</td>
<td>0.29</td>
</tr>
<tr>
<td>Fabricated Metal products</td>
<td>126</td>
<td>6.19</td>
</tr>
<tr>
<td>Machinery and equipment</td>
<td>174</td>
<td>8.55</td>
</tr>
<tr>
<td>Electronics</td>
<td>50</td>
<td>2.46</td>
</tr>
<tr>
<td>Others</td>
<td>148</td>
<td>7.28</td>
</tr>
<tr>
<td><strong>Total</strong></td>
<td><strong>2034</strong></td>
<td><strong>100</strong></td>
</tr>
</tbody>
</table>

Table 1.6: Regression Results for Hypothesis (i) to (iii)

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

Notes: *Significant at 10% level, **significant at 5% level, and *** significant at 1% level
Table 1.7: Regression Results for Hypothesis (iv)

<table>
<thead>
<tr>
<th>MODEL</th>
<th>Pooled IV/2SLS</th>
<th>Panel XTIV</th>
</tr>
</thead>
<tbody>
<tr>
<td>Invest</td>
<td>0.0543***</td>
<td>0.144**</td>
</tr>
<tr>
<td></td>
<td>(-0.0172)</td>
<td>(-0.0645)</td>
</tr>
<tr>
<td>Labemp</td>
<td>0.0789***</td>
<td>-0.0749</td>
</tr>
<tr>
<td></td>
<td>(-0.0179)</td>
<td>(-0.0664)</td>
</tr>
<tr>
<td>Conglo</td>
<td>0.0942***</td>
<td>-0.0401</td>
</tr>
<tr>
<td></td>
<td>(-0.0365)</td>
<td>(-0.0553)</td>
</tr>
</tbody>
</table>

Observations: 1253  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
Essay 2: Selection and Agglomeration Impact on Firm Productivity in Taiwan

1. Introduction

Evaluating the effectiveness of local policies designating science and technology corridors or parks requires an analysis of the productivity of firms located in those areas compared to firms located elsewhere. Given the large expenditures, often in terms of foregone tax revenues, associated with these policies it is important to understand their effectiveness and to better understand the mechanisms underlying any productivity gains. Dating back to Solow (1957), estimates of firm-level productivity are a key component of the heterogeneous firms’ literature that draws on Melitz’s (2003) model of describing how the productivity of firms determines their survival in domestic and foreign markets. However, the said paper by Melitz does not talk much about what determines actual productivity and leaves it to a random draw once the firm enters the market.

While productivity is a key metric of evaluating firm success, understanding how spatial policies designating science and technology parks impact this productivity requires additional analysis. The regional economics literature has shown that firms located in large cities are often more productive than those located elsewhere (Rosenthal and Strange, 2004). For industrial clusters, a positive association between regional plant density and their productivity has been empirically confirmed in the literature giving support for policies encouraging firm clustering (Ciccone and Hall, 1996).
However, recent theoretical developments in spatial economics with heterogeneous firms, indicates that the high productivity observed in large cities or industrial clusters may also result from competition-based selection (Combes et al. 2012). Thus as competition increases, firms above a certain productivity threshold are likely to survive while firms below this threshold exit the market. Besides, Baldwin and Okubo (2006) show that high productivity firms may self-select into large cities to take advantage of the economic benefits of large markets.

The motivation for the current research emanates from two sources. First the public incentives such as setting up a science park involve considerable expenditure for setting up the infrastructure and revenue loss which includes tariff exemptions and tax credits. Second the available literature on performance evaluation of science parks shows that the methodologies adopted are inconsistent and the empirical evidence on profitability, survival rates etc. is mixed which leaves little margin for any policy recommendation.

Over the past three decades, Taiwan’s government undertook several measures to encourage firms to spend more on innovative activity and to promote their technological capability. In this regard a well-known industrial technology policy in recent years is the Statute for Upgrading Industries (SUI), in which the most significant policy measure is concerning investment tax credits for R&D (Lien et al. 2007). Figures show that the amount of R&D expenditure increased steadily from NT$94.828 billion in 1992 to NT$280.980 billion in 2005. Correspondingly, the amount of R&D tax credits has increased more than ten times from NT$1.529 billion in 1992 to NT$16.318 billion in
2005. However, in the wake of recent fiscal difficulties and revenue shortfalls the policy tool of R&D tax credits has been widely criticized as being beneficial only for a few large firms rather than for the remaining 97 percent of small and medium-sized firms in Taiwan. More importantly, the policies of R&D tax credits favoring specific industries or firms may result in tax base erosion and destroys the fairness of the taxation system. It is estimated that these tax credits account for approximately one third of the NT$100 billion of total tax revenue loss for the Taiwanese government annually (Lien et al.).

In the current essay we extend the line of research used by Combes et al. by using firm-level panel data for Taiwan spanning the years 2009 through 2011 to simultaneously consider agglomeration and selection of firms in large cities and science parks in a single study. The analysis includes estimates for aggregate manufacturing and also specific industrial sectors segregated on the basis of technology intensity of the production process measured by percentage employment in technology oriented jobs (Hecker, 2005). Importantly, we highlight firms in the high-tech sector, which includes those involved in biotechnology, and where high firm-level productivity may generate comparative advantage. The available empirical evidence points to the potential for biotechnology to contribute to agricultural productivity gains and food security in emerging economies (Carter et al., 2011). While Taiwan’s biotech sector currently generates only NT$14 billion of exports, there is evidence that small, dedicated biotech companies that are R&D-intensive and operate primarily with venture capital, grants, initial public offerings and collaborative agreements can succeed in this sector (Lavoie and Sheldon, 2000).
Through its promotion of innovative activities, the Industrial Development Bureau’s long-term objective is for Taiwan to hold 3 percent of the world’s biotechnology market.

In terms of spatial analysis, we divide counties in Taiwan into three exclusive categories based on population density. These regions include counties with above median population density (large), counties with below median population density (small) and counties housing science parks. Using this delineation, for each market we estimate firm's total factor productivity (TFP) while controlling for potential simultaneity and selectivity bias using the Olley and Pakes (1996) method. Figure 2.1 gives a visual indication of the correlation between employment density and productivity.

Using estimates of firm’s TFP, we conduct three analyses. First at the aggregate manufacturing level, we compare the regional productivity distributions of firms in Taiwan and find that firms located in large cities exceed the productivity level of those located in science parks as shown in figure 2.2. Second we compare regional productivity distributions for a narrowly defined industry (NAICS-3 digit level) capturing the impact of benefits of locating in a science park. This analysis shows the surprising result that only firms using high technology production processes avail themselves of science park benefits and those using low level technology production have the lowest level of productivity. In the same analysis we compare the productivity distribution of scientific and technical services industry which reveals that science park firms are leaders. Finally we identify the impact of selection and agglomeration on firms’ productivity based on their spatial location in science parks. We show that firms located in science parks take advantage of agglomeration benefits from the specialization and diversity of economic
activity in their region. The selection effects although present are much less in magnitude as compared to the agglomeration effects. From a policy perspective, these results suggest that science parks do help in correcting innovation market failures but if extended to low-tech industries, they may turn out to be protection against market competition.

In this essay we have identified that the efficiency in utilization of public incentives offered via science park increases with the technology level of the industry. The research contribution of this essay is twofold. First, we add to the literature that evaluates firms within science parks keeping in mind the goals and objectives of parks. Our main finding here is that on average there is a positive relationship between the technology level of the industry and the total factor productivity of the firms operating within that industry. Thus bio-technology firms along with others operating in the science park have the highest level of productivity. Second, we also supplement the more popular performance analysis method by comparing the firms located in the science parks with the off-park firms. In this we find that on aggregate level the total factor productivity distribution of science park firms lags that of firms located in large cities but leads those located in small cities. A comprehensive overview of the research related to science park performance is given by Dabrowska (2011). The empirical evidence on the impact of science park intervention on innovative capability, survival rate, profitability and job creation is largely mixed and inconclusive (Monck, 2010) and therefore provides little margin for policy recommendation. In contrast, the research methodology presented here is not restricted by any particular estimation model or specific park objectives. Instead it
is based on a robust theoretical foundation and provides a minimum degree of homogeneity for similar evaluations.

2. Literature Review

Enterprises located in large cities are more productive. In the relevant literature there is a consensus on the positive relationship between productivity levels and regional density of labor, economic and industrial activity. Three main explanations have been presented for these observed phenomena. The first is agglomeration economies: economies external to firms arising out of sharing and spillovers and ultimately causing increasing returns for the entire neighborhood. The second is competition-based selection: firm heterogeneity results in their varying placement across the productivity scale and as selection is tougher in large urban areas so only the most productive firms may survive or profitably operate there. The third is sorting: *ex ante*, more productive firms or talented individuals may choose to locate in larger cities.

With respect to agglomeration economies associated with urban regions, a detailed review of relevant studies and their findings is reported in Rosenthal and Strange (2004). A very significant contribution by the same authors is the estimate that productivity increases by 3-8 percent if city size is doubled. Marshallian externalities are generally attributed to agglomeration economies associated with firms located in large cities and industrial clusters with the theoretical underpinnings dating back more than a century to the influential work of Marshall (1890). The agglomeration literature explains productivity gains resulting from labor market pooling, input sharing, and knowledge spillovers.
Apart from the agglomeration story, high level productivity observed in the case of large cities has recently been explained in terms of competitive selection associated with large markets. This explanation is based on the seminal work by Melitz (2003), who introduced product differentiation and international or interregional trade into the framework of industry dynamics of Hopenhayn (1992). Melitz and Ottaviano (2008) incorporated variable price–cost markups in this framework and showed that larger markets attract more firms, which makes competition tougher. As firms cluster to gain agglomeration economies, the increased competition resulting from this clustering may reduce profits and thereby their willingness to locate in denser locations. As a result, low productivity firms may choose to avoid or exit densely populated regions such as cities or science parks. Consequently the higher average productivity of firms and workers in larger cities may be the result of “natural” selection of firms.

There is a literature indicating sorting of high productivity firms into large markets. This self-selection phenomenon raises serious endogeneity concerns when evaluating the impact of spatial clustering policies on firm productivity (Baldwin and Okubo, 2006). Thus the sorting phenomenon is likely to confound much of the existing empirical literature on firm productivity along with the estimation of agglomeration benefits and congestion effects associated with clustering of firms.

The theoretical basis of this essay is the nested model of Combes et al. (2012) which distinguishes agglomeration effects from selection effects. For this, they extend Melitz and Ottaviano, by introducing agglomeration economies in the manner of Fujita and Ogawa (1982) and Lucas and Rossi-Hansberg (2002), who developed a model that
includes both selection and agglomeration effects. Thus under monopolistic competition with free entry, profits decline as the number of competitors increase in one location. This results in reduced survival for low-productivity firms. Combes et al. then structurally parameterized the strength of selection and agglomeration, and estimated the strength of these two effects using two-digit industry-level data.

In contrast to their approach, in this essay we focus on a sample of specific sectors (computer and electronics, chemicals industry and scientific and technical services) rather than the manufacturing sector only, so that we can control for sector-specific factors such as market conditions for supply of inputs and demand for output and the form of production functions. Further, using Syverson’s (2004) approach we use proxies for shift, dispersion and truncation in the log TFP distributions across the regions in order to estimate the impact of agglomeration and selection. The possibility of self-selection bias is controlled using the two-stage Heckman (1979) selection model.

The empirical analysis conducted in this essay depends a lot on the estimation of a bias-free TFP distribution. The estimation method used involves that proposed by Olley and Pakes (1996). Olley and Pakes's technique is robust to two econometric concerns: simultaneity and selectivity bias. However, the proxy variable for free inputs in Olley and Pakes' method is firm's investment. Often datasets report missing values regarding investments made by firms and thus a large number of observations have to be dropped in the estimation process. To avoid this, Levinsohn and Petrin’s (2003) method is often adopted, which uses intermediate inputs to proxy for productivity shocks. Given the limitations of the dataset available for this study, we use return on capital as a proxy for
investment while estimating TFP through the Olley and Pakes method. However, for the biotechnology sector, where the dataset does not report any exits from the market, we have used the Levinsohn and Petrin’s technique to estimate the log-TFP.

Many definitions of science parks have been proposed, mostly by professional organizations (e.g., AURP, 1998 and UNESCO, 2006) and by parks themselves as a way to define their activities. Common among these definitions is that a park is a type of public-private partnership that fosters knowledge flows—often between park firms and universities and among park firms—and contributes to regional economic growth and development. Empirical support for the agglomeration effects in a park is provided by Jaffe (1989), Jaffe et al. (1993), Audretsch (1998), and Rothaermel and Thursby (2005a, 2005b). However, there are also some disadvantages associated with being in a park. When a park attracts many firms which then have access to the same technologies, those firms may expect greater competition in the use of those technologies. On the human capital supply side, there is skilled and specialized labor available from universities involved in parks in the form of graduate students and consulting faculty, although there is more competition for that pool of human capital.

3. Theoretical Model and Empirical Strategy

How do agglomeration and selection in large cities and science parks impact firms’ productivity distribution? This section presents the theoretical model of productivity improvement in various regions and proposes an idea for identifying agglomeration and selection effects. For this essay we shall use the model developed by Combes et al. (2012).
General framework of the model

Modifying and applying the model of Combes et al., we describe the theoretical background of the productivity improvement effects in large cities and science parks in Taiwan.

Preferences and demand

First, we introduce the general framework of the model. A consumer’s utility is given as follows,

\[
U = q^0 + \alpha \int_{i \in \Omega} q^i di - 1/2 \gamma \int_{i \in \Omega} (q^i)^2 di - 1/2(\int_{i \in \Omega} q^i di)^2
\]

where \( q^i \) denotes the consumption of variety \( i \) of a set \( \Omega \) of differentiated varieties of manufactured goods and \( q^0 \) is the numeraire good. The numeraire good is produced under constant returns to scale using one unit of labor per unit of output which implies that the cost to firms of hiring one unit of labor is always unity. Differentiated products are produced under monopolistic competition. By incurring a sunk entry cost \( s \) a firm manufactures a product using \( h \) units of labor per unit of output. The value of \( h \) differs across firms depending on their productivity and is randomly drawn, from a distribution with known probability density function \( g(h) \) and cumulative \( G(h) \) common to all regions. Using demand function for variety \( i \) we solve the utility maximization problem subject to the budget constraint. Taking \( P \) as the average price of varieties with positive consumption the demand function for variety \( i \) can be written as follows:

\[
q^i = \left\{ \frac{1}{\gamma + \eta \omega} (\alpha + \eta \omega P) - \frac{1}{\gamma} p^i \right\} \text{ if } p^i \leq h^i, 0 \text{ otherwise}
\]
Production

Following Arimoto et al. (2011) we index firms by their unit labor requirement \( h \) and write the total sales of a firm as \( Q(h) = Cq(h) \) where \( C \) is the mass of consumers. Firms maximizes their profit as follows:

\[
\pi(h) = [p(h) - h]Q(h)
\]

In the monopolistically competitive industry firms enter until \textit{ex-ante} profits become zero which is given by the following condition,

\[
\frac{C}{4\gamma} \int_{h^d}^{h^d} \left( h^d - h \right)^2 dG(h) = s
\]

(4)

At the cut-off point of zero marginal profit, \( h^d \) we have \( h^d = p(h^d) \),

\[
h^d = \frac{1}{\eta\omega + \gamma} (\gamma \alpha + \eta \omega P)
\]

(5)

Using the optimal pricing rule we get the zero cut-off profit condition as.

\[
N \equiv \omega = \frac{2\gamma \alpha - h^d}{\eta h^d - H}
\]

(6)

where \( N \) is the mass of surviving firms and which is equivalent to mass of actually produced varieties.

Combes et al. then introduce agglomeration economies as in Fujita and Ogawa (1982); Lucas and Rossi-Hansberg (2002), while assuming that each worker supplies a single unit of labor. If the agglomeration effect is present, we assume that the workers’ productivity increases with the number of firms within a region. That is, effective labor
supply by a single worker is \( a(N), a' > 0, a'' < 0 \) and \( a'(0) = 1 \). On the other hand, if agglomeration of firms does not improve workers’ productivity, for any value of \( N \), we have \( a(N) = 1 \). We also assume that if the agglomeration effect is present, it benefits workers across both the differentiated good and the numeraire good sectors. Moreover we denote the proportion of firms that fail to survive product market competition in city \( i \) (a local measure of the strength of selection) by,

\[
S_i \equiv 1 - G(h^d_i) \tag{7}
\]

Given agglomeration effects, a firm of unit labor requirement \( h \) hires

\[
I(h) = Q(h)h / a(N)
\]

Taking logs, we obtain \( \phi = \ln(Q/l) = \ln[a(N)] - \ln(h) \). Using change of variable theorem the probability density of firms’ log productivities as

\[
f(\phi) = \begin{cases} 
0 & \text{for } \phi \leq A - \ln(h^d) \\
\frac{e^{\phi - A}}{G(h^d)} \left( e^{A - \phi} \right) & \text{for } \phi > A - \ln(h^d) \end{cases} \tag{8}
\]

where \( A = \ln[a(N)] \).

**Hypotheses**

Using the above model we develop the following two hypotheses:

**Hypothesis 1 (Agglomeration)** The increase in the number of firms in a region shifts the log productivity distribution to the right.
Hypothesis 2 (Selection) The higher entry cost increases the cut-off unit labor requirement of survival plants. This is reflected through the extent of left truncation of the log productivity distribution of firms in different regions.

TFP Estimation

The econometric analysis conducted in this essay primarily hinges on estimation of TFP. The log-TFP distribution of firms located in any region is then predicted from the residual of the equation. For this study firm-level TFP is calculated assuming that the technology for revenue generated is Cobb-Douglas in factors of production:

\[ Y_{it} = A_t K_{it}^{\beta_k} L_{it}^{\beta_l} \]  

(9)

where for firm \( i \) at time \( t \), \( Y_{it} \) is physical output, \( K_{it} \) and \( L_{it} \) are the inputs of capital and labor and \( A_t \) is the Hicks-neutral efficiency level of the firm. \( A_t \) is unobservable to the researcher. Equation (1) can be written in logarithmic form as:

\[ \ln Y_{it} = \beta_0 + \beta_k \ln K_{it} + \beta_l \ln L_{it} + \varepsilon_{it} \]  

(10)

From (9) and (10) we can deduce that \( \ln (A_t) = \beta_0 + \varepsilon_{it} \) where \( \beta_0 \) is the mean efficiency level across firms over time and \( \varepsilon_{it} \) is the deviation from the mean and can be further decomposed in an observable and unobservable component:

\[ \ln Y_{it} = \beta_0 + \beta_k K_{it} + \beta_l L_{it} + \gamma_{it} + u_{it} \]  

(11)

In (11) firm-level productivity is \( \omega_{it} = \beta_0 + \gamma_{it} \) and \( u_{it} \) is the i.i.d. measurement error term. The productivity level can be obtained from (11) by taking the exponential of the estimated \( \omega_{it} \) .
**Possible Sources of Bias in TFP estimation**

The productivity estimate from (3) could suffer from simultaneity bias, competitive selection bias and multi-product bias, each of which is discussed in detail as follows:

**Endogeneity or Simultaneity Bias**

An OLS estimate of (3) can be unbiased only if the inputs to production are exogenous from the firm's productive efficiency. However Marschak *et al.* (1944), long ago indicated that these inputs are not independently determined as firms themselves either observe or are able to predict their efficiency and hence determine the quantity of freely determined inputs accordingly. As the firm's productivity is not observed by the econometrician, its correlation with inputs causes simultaneity bias in the estimation (De Loecker, 2007). The direction of the bias depends on the intensity of factor-use in the production process.

Levinsohn and Petrin (2003) illustrate, for a two-input production function where labor is the only freely variable input and capital is quasi-fixed, that the capital coefficient will be biased downward if a positive correlation exists between labor and capital. Another relevant issue raised by Olley and Pakes (1996) relates to the entry and exit of firms which is traditionally dealt with in TFP estimation by constructing a balanced panel, i.e., by omitting all firms that enter or exit over the sample period. However, several theoretical models such as that of Hopenhayn (1992) predict that the growth and exit of firms is motivated to a large extent by productivity differences at the firm level. Since low productivity firms have a stronger tendency to exit than their more productive counterparts, omitting all firms subject to entry or exit is likely to lead to
biased results. If firms have some knowledge about their productivity level $\omega_{it}$ prior to their exit, this will generate correlation between $\omega_{it}$ and the fixed input capital (Ackerberg et al. 2007). This correlation has its origin in the fact that firms with a higher capital supply will, ceteris paribus, be able to withstand lower $\omega_{it}$ without exiting. In sum, the selection bias or “endogeneity of attrition”-problem will generate a negative correlation between $\omega_{it}$ and $k_{it}$, causing the capital coefficient to be biased downwards in a balanced sample.

**Selection Bias**

Firms’ entry or exit in a market is determined to a great extent by their initial productivities as studied by Fariñas and Ruano (2005) for Spanish manufacturing firms. As the likelihood of a firm's survival is dependent on its productivity level $\omega_{it}$, any knowledge about this prior to the decision to remain in the market or exit will generate correlation between $\varepsilon_{it}$ and fixed input capital (Ackerberg et al.). This correlation is due to the fact that firms with a higher capital supply will, ceteris paribus, be able to survive with lower $\omega_{it}$ relative to firms with a lower capital stock (Van Beveren, 2010).

**Multiproduct Bias**

Firms’ decisions about the range of goods to produce are typically made at a more disaggregated level than is available in manufacturing data sets (Bernard et al., 2009). If firms produce multiple products within the same industry and if these products differ in their production technology or in the demand they face, this will lead to biased TFP
estimates, because the production function assumes identical production techniques across products manufactured by a unit firm.

4. Econometric Analysis

TFP Estimation Techniques

In what follows, the techniques used in this essay for estimation of unbiased and consistent production function coefficients are described. As noted above, OLS estimates are likely to yield biased values of the coefficients, and as a consequence we use two stage least squares with instrumental variables (IV), along with the semi-parametric Olley and Pakes (1996) and Levinsohn and Petrin (2003) techniques. We did not use fixed effects estimation as it depends on the strong assumption that productivity is time-invariant. Also, as noted by Wooldridge (2009), the fixed effects estimator assumes strict exogeneity of the inputs which is not very likely and implies that inputs are not affected by the firm's knowledge of productivity.

Instrumental Variables (IV)

An alternative method to achieve consistency of coefficients in the production function is by using instrumental variables for the endogenous independent variables, i.e., the freely alterable inputs in the production function. Unlike the fixed effects estimator, IV methods do not rely on strict exogeneity of the inputs for consistent estimation as shown in Wooldridge.

Greene (2004) has pointed out three requirements for achieving consistent estimates. First, instruments need to be correlated with the endogenous regressors (inputs). Secondly, the instruments cannot enter the production function directly. Finally,
the instruments should not be correlated with the error term (and hence with productivity).

**Olley and Pakes Estimation Methodology**

Olley and Pakes were the first to introduce a semi-parametric estimation algorithm that takes both the selection and simultaneity problem directly into account. This estimator solves the simultaneity problem by using the firm’s investment decision as proxy for unobserved productivity shocks.

Selection issues are addressed by incorporating an exit provision into the model. At the start of each period, each surviving firm decides whether to exit or to continue its operations. If it exits, it receives a particular sell-off value. If it continues, it chooses an appropriate level of variable inputs and investment. The firm is assumed to maximize the expected discounted value of net cash flows and investment and exit decisions will depend on the firm’s perceptions about the distribution of future market structure, given the information currently available\(^2\).

The Olley and Pakes technique is based on three key assumptions. First, the only unobserved state variable is the firm’s productivity which evolves as a first-order Markov process. Second, investment needs to be monotonic with the productivity and hence during econometric analysis non-negative values of investment variable are required. Third, deflation on the basis of industry level prices implies that all the firms face the same prices. (Van Beveren, 2010).

\(^2\) Yasar *et al.* (2008) have developed a canned Stata routine -opreg-to estimate the log of total factor productivity following the Olley and Pakes algorithm.
The salient steps of the estimation process are as follows. The investment is shown as a function of capital and productivity as \( i_t = i_t(k^*, \omega) \). The monotonicity assumption allows its inversion as \( \omega_t = h_t(k^*, i_t) \) so that productivity can be expressed in terms of capital and investment.

The Olley and Pakes technique proceeds in two stages. In the first-stage regression, using the above relationship in (10) the free input variable(s) coefficients are derived. The second stage evaluates the temporal productivity level to compare it with the lower bound or the threshold. Using coefficients form the first stage and survival probability and by applying non-linear least squares method the coefficients on the capital variable is estimated. For details the relevant reference is Van Beveren.

Although the Olley and Pakes technique is robust to simultaneity and selectivity problems, the empirical estimation using it may return unreliable results if either the investment variable has non-positive values or there are no firms exiting the market. An alternative method is to use the Levinsohn and Petrin method which takes care of the simultaneity problem by using intermediate inputs as proxy for productivity instead of investment.

*Empirical Analysis*

The main objective of this essay is to find out how agglomeration and competitive selection affect regional productivity distribution. To reach at some reliable estimates in this direction, the first and fundamental step is to arrive at unbiased TFP for the firm. Therefore much of the effort in this section is focused on how to determine consistent
TFP estimates. The estimates are computed keeping in consideration the practical issues pointed out in the previous section.

Data

To determine the selection and agglomeration effects on firms’ TFP in Taiwan we use firm-level data disaggregated at the county-industry (3-digit NAICS) level from ISI Emerging Markets Information Services (EMIS). The unbalanced panel data are for the years 2009 to 2011. The dataset has four main fields indicating the physical location, industry, operational status of the firm, and its listing and trading status on the stock market. The dataset also provides information about financial indicators relating to balance sheet and income statements such as non-current assets and sales revenues along with data on the profitability, liquidity and growth trend ratios. We extract information about each firm’s total operating revenues, assets and number of employees to estimate the production function parameters. The industry classification is done at 3-digit NAICS level.³

For this essay, we supplement the dataset with county-level income and industry price data available at the website of National Statistics Office (DGBAS), Taiwan. These data is used to deflate the revenue figures and form deep lagged instrumental variables to be used with the 2SLS/IV method.

Data Cleaning

³ The dataset used in the study limits the analysis as it does not provide information about intermediate inputs or energy requirements of the firm. Also the dataset provides no details about the product mix of the firms. However, detailed examination of annual reports for firms operating in NAICS 334 show that technology, inputs and sales are broadly homogeneous.
We cleaned the raw data containing 4662 observations using several steps. First, we deflate the revenue figures by industry-level prices for the year 1996. Second using box plots we examine the data for extreme outliers and remove the entities with top and bottom 1 percent TFPs to avoid their influence on the results. This results in a final dataset of 4655 observations. Table 2.1 gives the summary statistics of the mean and standard deviation of inputs and outputs used in the Cobb-Douglas production function.

Table 2.2 shows the county-wise location of select industries. The dataset gives the 3-digit NAICS for all the firms, although it also provides 4-digit classification for a subset of these enterprises. This helps in detailed TFP analysis while segregating the firms in terms of the technology intensity of the production. For NAICS 325 we have a total of 310 observations of which 71 are in the pharmaceutical sector (3254) and the rest are in basic chemical manufacturing (3251). It can be seen that computer and electronics firms (NAICS 334) constitute half of the total number of observations. Here, from the total of 2150 observations, 389 are for semiconductor manufacturing (3344). Finally we look at the scientific and technical industry (NAICS 541) in which case we have around 20 observations belonging to the biotechnology industry. All these industries have their presence in all the three regions namely science park counties, small cities and the large cities.

As the focus of this essay is on agglomeration and selection analysis the geographical unit of estimation of each market is the county. This division is justified, due to the fact that for big cities the market effects are likely to spill over the entire county. In the case of science parks particularly the Hsinchu Science Park, ever
increasing demand has forced a greater area in the county being designated as the science park. Based on population and labor density statistics we classify Taipei County, New Taipei City, Keelung City and Chiayi City as the large cities. The counties designated Science Park counties are Hsinchu County, Tainan City, Yunlin City and Kaohsiung City.

5. Results

The results for coefficients of input factors are shown in table 2.3.

**TFP estimates using OLS**

The baseline TFP estimates are computed using OLS. The OLS estimate of (11) requires that $E(x_{it} \omega_{it}) = 0$. As for the firm it is possible to observe or anticipate its productivity and thus decide the level of the inputs. The more flexible is the nature of the input, the possibility of adjusting its level based on the expected productivity becomes more likely. In this estimation it may be difficult for the firm to change its capital input but labor can be adjusted very easily in a short time. To test the reliability of OLS estimates we perform the Durbin-Wu-Hausman test of endogeneity. The small p-value indicates that the estimates are not reliable.

**Olley-Pakes Method**

Keeping in mind the shortcomings of the techniques used above, we finally estimate TFP using the method proposed by Olley and Pakes (1996). The standard errors of all Olley-Pakes’ estimation routines are bootstrapped using 200 replications. The TFP distributions were drawn for the cities with above and below the median population density and for the firms located in science parks.
In this approach, we use the return on capital as proxy for investments made by the firm along with control variables such as the number of employees to control for size. Using the TFP estimates form the Olley and Pakes method we examine the summary statistics for each of the regions as detailed in the Table 2.4. It is evident that large cities have the highest mean value followed by that of the science park firms. The inter-quartile ratio (IQR) for each region indicates that big cities are the ones that benefit most from agglomeration economies showing the largest dispersion.

Robustness Check in TFP Estimation

As part of robustness check I estimate three additional TFP measures: labor productivity, TFP from the Levinsohn and Petrin (2003) and the Ackerberg et al. (2006). Ackerberg et al. have pointed out the likelihood of collinearity in inputs in the Olley and Pakes and the Levinsohn and Petrin approaches. The authors consider that labor may not be chosen independently, but rather be function of capital and productivity. To avoid this eventuality we use Wooldridge (2009) who argues that both Olley and Pakes and Levinshon and Petrin two-step estimation procedures can be reconsidered as consisting of two equations that can be jointly estimated by GMM in a one-step procedure. These alternative productivity measures to the Olley and Pakes method confirm that the main results remain consistent. However labor productivity results cause overestimation in the size and significance of agglomeration variables.

Agglomeration and Selection

The focus of this part is on firms operating in NAICS 334 in all the three regions of Taiwan. In order to identify the impact of agglomeration we use two variables namely
Localization economies and urbanization economies. Following Henderson et al. (1995) we define localization as the regional employment share of the specific industry (defined at the three-digit NAICS level) in the manufacturing sector:

\[
\text{Localization: } \frac{\text{Employment}_{j,r}}{\text{Employment}_{r} / \text{Employment}_{\text{tot}}} \]

for industry \(j\)- in region \(r\) at time \(t\).

Urbanization is measured using the Herfindahl-Hirschman Index which is computed as \(\sum_j s_{jr}^2\) where \(s_{jr}\) is the employment share of two digit manufacturing industry \(j\) (except the industry under consideration) in region \(r\) at time \(t\).

In addition, as noted earlier, agglomeration may entail diseconomies, for example, through pollution or higher land rents. Since we do not have information on industrial land prices, we have used population density instead, following a number of authors including Guimarães et al. (2000). It can be argued that population density may in fact capture demand-side agglomeration economies, that is, firms locating near their potential markets. However, given the dominance of exporting firms, the relevant market for these firms in Taiwan is not the local market, hence there is the possibility that population density may not actually capture market-size effects.

At this point the main econometrics-related concern that still needs to be addressed before conducting agglomeration analysis is the likelihood of self-selection of heterogeneous firms in markets with specific characteristics. While determining heterogeneous firms’ location-choice decision, Baldwin and Okubo (2006) show that high-productivity firms self-select into large markets. This self-selection, also referred to
as sorting by high-productivity firms producing substitutable product varieties, is motivated by the potential of higher profits from a large market. Hence, the average productivity level in large markets is expected to be higher than that in small markets. In using the Olley and Pakes technique for estimation of production functions we have already taken care of the survival-based selection of the firms, hence we focus now on Baldwin and Okubo’s self-selection, where surviving firms sort into different regions depending on their productivity and regional characteristics, i.e., high (low) productivity firms concentrate in a region with a large (small) market.

We term the TFP estimates from Olley and Pakes to obtain distributional measures of regional market productivity median, IQR and 10th percentile values. By regressing these measures of regional productivity distribution on variables representing agglomeration economies and market competition, we can find their significance and direction. Finally, the effects of agglomeration economies and self-selection are numerically compared to identify which of the two contributes more to a region’s productivity level.

Identification of Firm Self Selection
To identify the process through which high-productivity firms sort into science parks and large cities we use a selection and an outcome equation. Considering firm’s sorting in science parks the relevant selection equation is as follows:

\[ z_{it}^* = \alpha_0 + \alpha C_{it} + \varepsilon_{it} \]  

where \( z_{it}^* \) is \( z_{it} = 1 \). \( z_{it} \) is the dependent variable of the select equation which is binary in nature and \( C_{it} \) are the self-selection choice variables. The choice variables include lagged
county level wages, lagged county population density, and firms’ return on capital and return on equity. The outcome equation is given as follows:

\[
S_{prt} = \beta_0 + \beta_a A_{rt} + \beta_c X_{rt} + \nu_{prt}, \text{ if } z^{*}_a > 0
\]  

(13)

where \( S_{prt} \) is the \( p \)-th percentile of agglomeration or selection variable in region \( r \) at time \( t \), \( A_{rt} \) are industry-specific agglomeration variables for region \( r \) at time \( t \), \( X_{rt} \) are the region-time specific control variables and \( \nu_{prt} \) is the error term. The expected sign of the agglomeration coefficient is positive.

To estimate the selection effect we use the Heckman two-step estimator for selection models (Heckman, 1979). Such models are common in micro-econometric studies, in the estimation of wage equations or consumer expenditure. If the coefficient on the inverse Mill’s ratio is statistically significant, there is selection bias. For this study we have the following instruments: log of population density in 1950, log of return on equity and capital. The validity of instruments is established using the Sargan (1958) test of over-identification restrictions. The results confirm that the Science Park or large city dummy is positive and significant in the analysis.

6. Agglomeration and Selection-Controlling Self Selection

After determining estimates for log TFP distributions for the regions the following regression analysis is conducted to find out the impact of agglomeration on right shift, dispersion and truncation of the distribution. As the issue relating to self-selection is still there we consider these as raw productivities. We now use the Heckman model to
establish whether self-selection is positive and significant. The following variables are generated based on Syverson (2004):

i. Mean (median) - to check for relative shift

ii. IQR - for dispersion

iii. 10th percentile - for truncation/cut-off

Using these as dependent variables we find their significance with respect to agglomeration variables (localization and urbanization) and selection (population density). We repeat these steps for big cities, small cities and science parks and for different industries at the 3-digit NAICS level. To account for the panel structure of the data we first transform the data into a form suitable for fixed effects analysis and then apply the Heckman procedure.

Robustness Check for Firm Self-Selection to Science Parks/Large Cities

Apart from using the Heckman (1979) model we also use dummy variables for each region in the instrumental variables regression to see if they are positive and significant and control the self-selection. If this type of endogeneity exists then instead of large concentration of firms in cities impacting the individual firm's productivity, it is the firm's self-selection which results in greater concentration of high productivity firms in any region. This possibility of reverse causality can be controlled through the use of instruments correlated with firm's productivity but not correlated with agglomeration.

7. Discussion of Results

The results for the current research can be divided into three parts. The first relates to the non-parametric comparisons of the log TFP distribution for manufacturing firms located
in the three identified regions. For the overall manufacturing sector the firms located in
the cities with above median population density have the highest mean TFPs. Also the
TFP distribution here is more dispersed and has the highest minimum value indicating
greater within region competition. Followed by this, the firms located in science parks
depict similar characteristics. As the analysis becomes more industry-specific for NAICS
334, 325 and 541 we find that firms in science parks show varying trends in TFP
distribution. The TFP distributions for the selected industries are shown in figures 2.3,
2.4 and 2.5 respectively. The chemicals industry shows that firms located in science parks
have the lowest productivity level whereas the scientific and technical services industry
including the bio-technology sector has the highest productivity firms located in science
parks.

Analyzing the results for the impact of agglomeration and selection, the Heckman
selection model confirms that firms do self-select in regions of high productivity.
However, even after controlling for the self-selection, we find that the agglomeration
variables, localization and urbanization, are statistically significant. The regression results
indicate that selection due to competition is also significant. However the coefficients for
selection are much smaller than those of agglomeration variables. Table 2.5 gives the
results of these regressions.

8. Conclusion
Firms located in science parks have productivity distributions proportional to the
technology intensity of their sector. Also, even after controlling for the self-selection
bias, firms located in science parks benefit from both types of agglomeration economies
namely specialization and diversification. The results also confirm that self-selection in science parks by high productivity firms is empirically established. The elasticity of competition based selection is much less than the elasticity of agglomeration variables. Thus science park incentives insulate firms from the competition they might face in open markets. This fact is even demonstrated in the case of low-tech firms which have a productivity distribution that lags even that of small cities.

The regional productivity distributions show that the relative intensity of economic and or industrial activity causes right shift and greater dispersion. Also firms in large cities face competition analogous to being in an open economy. Thus firms below a certain threshold level of productivity cannot survive there. Also industrial clusters such as science parks are not always sufficient to provide positive productivity shocks to incumbent firms.

The policy implication that arises from this study is based on robust theoretical foundations. We have tried to tease out the impact of policy on firm’s productivity; the indicator of its heterogeneity. The interplay of selection and agglomeration with probability of sorting makes the analysis a daunting task. However, controlling for various observable and unobservable factors, the study suggests that incentives such as science parks do contribute in productivity improvements of the firms. The level to which benefits of science parks are availed by firms as depicted in their productivity depends on the underlying technology of the process.
9. Figures and Tables

Figure 2.1: Population density and TFP (County-level for Taiwan). Map based on data used in the study. The trend is increasing from light (yellow) to dark (brown)
Figure 2.2: Kernel density plots for the three regions

TFP Distribution for all Industries

- Dotted line: Small
- Dashed line: Science Park
- Solid line: Large

kernel = epanechnikov, bandwidth = 0.1608
Figure 2.3: Kernel density plots for Computer and Electronics Firms for the three regions
Figure 2.4: Kernel density plots for Chemical Manufacturing Firms for the three regions
Figure 2.5: Log–TFP Distribution for NAICS 541
<table>
<thead>
<tr>
<th>Variable</th>
<th>Mean</th>
<th>Std. Dev.</th>
<th>Max</th>
</tr>
</thead>
<tbody>
<tr>
<td>Capital</td>
<td>9,031,678</td>
<td>41,300,000</td>
<td>1,520,000,000</td>
</tr>
<tr>
<td>Revenue</td>
<td>9,724,772</td>
<td>44,300,000</td>
<td>845,000,000</td>
</tr>
<tr>
<td>Labor</td>
<td>660</td>
<td>1,770</td>
<td>33,669</td>
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</table>
Table 2.2: Summary Stats-II

<table>
<thead>
<tr>
<th>State/County</th>
<th>325</th>
<th>334</th>
<th>541</th>
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</thead>
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<tr>
<td>Changhua County</td>
<td>6</td>
<td>14</td>
<td>2</td>
</tr>
<tr>
<td>Chiayi City</td>
<td>3</td>
<td>3</td>
<td>1</td>
</tr>
<tr>
<td>Hsinchu County</td>
<td>20</td>
<td>474</td>
<td>11</td>
</tr>
<tr>
<td>Hualien County</td>
<td>0</td>
<td>0</td>
<td>1</td>
</tr>
<tr>
<td>Kaohsiung City</td>
<td>29</td>
<td>82</td>
<td>9</td>
</tr>
<tr>
<td>Keelung City</td>
<td>0</td>
<td>6</td>
<td>1</td>
</tr>
<tr>
<td>Miaoli County</td>
<td>12</td>
<td>40</td>
<td>1</td>
</tr>
<tr>
<td>Nantou County</td>
<td>6</td>
<td>4</td>
<td>1</td>
</tr>
<tr>
<td>New Taipei City</td>
<td>23</td>
<td>600</td>
<td>22</td>
</tr>
<tr>
<td>Penghu County</td>
<td>0</td>
<td>0</td>
<td>1</td>
</tr>
<tr>
<td>Pingtung County</td>
<td>0</td>
<td>6</td>
<td>1</td>
</tr>
<tr>
<td>Taichung City</td>
<td>18</td>
<td>78</td>
<td>6</td>
</tr>
<tr>
<td>Tainan City</td>
<td>28</td>
<td>68</td>
<td>2</td>
</tr>
<tr>
<td>Taipei</td>
<td>138</td>
<td>430</td>
<td>55</td>
</tr>
<tr>
<td>Taitung County</td>
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<td>0</td>
<td>0</td>
</tr>
<tr>
<td>Taoyuan County</td>
<td>23</td>
<td>339</td>
<td>10</td>
</tr>
<tr>
<td>Yilan County</td>
<td>4</td>
<td>3</td>
<td>0</td>
</tr>
<tr>
<td>Yunlin County</td>
<td>0</td>
<td>3</td>
<td>1</td>
</tr>
<tr>
<td><strong>Total</strong></td>
<td><strong>310</strong></td>
<td><strong>2,150</strong></td>
<td><strong>125</strong></td>
</tr>
<tr>
<td>Model/Variables</td>
<td>OLS</td>
<td>IV/2SLS</td>
<td>OP</td>
</tr>
<tr>
<td>------------------</td>
<td>-----------</td>
<td>-----------</td>
<td>-----------</td>
</tr>
<tr>
<td>Capital</td>
<td>0.37***</td>
<td>0.56***</td>
<td>0.29 **</td>
</tr>
<tr>
<td>Labor</td>
<td>0.56***</td>
<td>0.21 ***</td>
<td>0.47**</td>
</tr>
<tr>
<td>R-squared</td>
<td>0.62</td>
<td>0.57</td>
<td></td>
</tr>
<tr>
<td>Sargan Test(p-value)</td>
<td>-</td>
<td>0.77</td>
<td></td>
</tr>
<tr>
<td>DWH (p-value)</td>
<td>0.0002</td>
<td>0.265</td>
<td></td>
</tr>
</tbody>
</table>

Notes: * Significant at 10% level, **significant at 5% level, and *** significant at 1% level
### Table 2.4: Region-wise Log-TFP Distribution Stats
(AM: Large City, BM: Small City, SP: Science Park)

<table>
<thead>
<tr>
<th>Stats</th>
<th>BM</th>
<th>SP</th>
<th>AM</th>
</tr>
</thead>
<tbody>
<tr>
<td>N</td>
<td>840</td>
<td>1427</td>
<td>2388</td>
</tr>
<tr>
<td>mean</td>
<td>4.106923</td>
<td>8.32283</td>
<td>11.76685</td>
</tr>
<tr>
<td>sum</td>
<td>13409.1</td>
<td>27174.04</td>
<td>38418.78</td>
</tr>
<tr>
<td>max</td>
<td>8.708421</td>
<td>12.10286</td>
<td>17.08633</td>
</tr>
<tr>
<td>min</td>
<td>-2.43337</td>
<td>1.005013</td>
<td>4.605112</td>
</tr>
<tr>
<td>range</td>
<td>11.14179</td>
<td>11.09784</td>
<td>12.48122</td>
</tr>
<tr>
<td>sd</td>
<td>1.043982</td>
<td>1.096338</td>
<td>1.116861</td>
</tr>
<tr>
<td>variance</td>
<td>1.089898</td>
<td>1.201957</td>
<td>1.247379</td>
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<tr>
<td>skewness</td>
<td>0.098394</td>
<td>0.024502</td>
<td>0.384866</td>
</tr>
<tr>
<td>kurtosis</td>
<td>4.706174</td>
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</tr>
<tr>
<td>p50</td>
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<td>8.291471</td>
<td>11.66475</td>
</tr>
<tr>
<td>p5</td>
<td>2.549411</td>
<td>6.604828</td>
<td>10.17849</td>
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<td>p10</td>
<td>2.932698</td>
<td>6.96137</td>
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<tr>
<td>p25</td>
<td>3.461043</td>
<td>7.634048</td>
<td>11.01647</td>
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<tr>
<td>p50</td>
<td>4.063416</td>
<td>8.291471</td>
<td>11.66475</td>
</tr>
<tr>
<td>p75</td>
<td>4.691591</td>
<td>8.983652</td>
<td>12.43476</td>
</tr>
<tr>
<td>p90</td>
<td>5.439116</td>
<td>9.73185</td>
<td>13.19089</td>
</tr>
<tr>
<td>p95</td>
<td>5.90151</td>
<td>10.1574</td>
<td>13.67761</td>
</tr>
<tr>
<td>p99</td>
<td>6.822562</td>
<td>11.15639</td>
<td>14.81686</td>
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<tr>
<td>IQR</td>
<td>1.230548</td>
<td>1.349604</td>
<td>1.418283</td>
</tr>
<tr>
<td>LOC</td>
<td>URB</td>
<td>Lab</td>
<td>LOC</td>
</tr>
<tr>
<td>-----</td>
<td>-----</td>
<td>-----</td>
<td>-----</td>
</tr>
<tr>
<td>1.89***</td>
<td>-3.47***</td>
<td>-.07**</td>
<td>0.48***</td>
</tr>
<tr>
<td>(.10)</td>
<td>(0.16)</td>
<td>(0.02)</td>
<td>(0.01)</td>
</tr>
</tbody>
</table>

Notes: * Significant at 10% level, **significant at 5% level, and *** significant at 1% level
Essay 3: Does Trade Liberalization Causes Growth in Domestic Credit? A Study for Countries in Sub-Saharan Africa

1. Introduction
Trade liberalization has, *ceteris paribus*, the potential to vary the productivity cut-off thresholds for both domestic and exporting firms (Melitz, 2003). In the domestic market there is a weeding out of inefficient firms as competitive selection forces low productivity firms to exit. In the export market, such reform brings down the threshold level of the cut-off productivity. Thus, whereas the opening up of the economy may cause some low productivity domestic firms to shut down, it also increases the probability that firms just below the lower bound of the pre-reform cut-off productivity enter the export market in the post-reform regime. Catering for both home and foreign markets most likely leads to higher revenue generation than producing for the home market alone. The higher profit earning potential of prospective exporters is one of the main reasons that, makes investment in these firm a profitable venture.

Ideally, the efficiency gains due to trade liberalization cause an overall reallocation of resources, that is, factors of production within the economy move towards the sectors enjoying Ricardian comparative advantage. The recent trade and industry literature based on the seminal work of Melitz, shows that it is the productivity differences across heterogeneous firms that, ultimately determines the sector and extent
of the comparative advantage of a country. Nevertheless, firms may have to take conscious investment decisions to overcome financial constraints and improve their placement on the productivity spectrum. The reallocation of factors of production following the opening up of the economy is a short term phenomenon compared to the long-run advantages of trade liberalization. However, from a policy perspective it is imperative to connect these short-run impacts to long-term advantages to fully appreciate the benefits of free trade.

A rich literature dealing with the financial frictions faced by firms in developing countries shows that often entrepreneur’s investment decisions are credit constrained, see, for example, Manova (2013). As exports require finance to cover the fixed costs related to foreign market entry, credit constrained firms are dependent on external finance resources. Against this demand for finance, creditors choose to make investments keeping in consideration the opportunity cost of the venture. Trade liberalization, *per se*, makes such investments profitable and thus helps in diversion of resources to more productive sectors of the economy.

Credit demand is driven by firms’ need to finance current and future output, and expectations about the rate of return on new investment. Accordingly, credit demand is negatively affected by borrowing costs, and is positively related to current income and wealth, borrowers’ expectations about future income and asset valuations, and the current and future rates of return on capital. Firms have higher expectations of profits once they enter the export markets and so they have a higher demand for credit. The supply of credit is positively related to the rate of return on equity, disposable income, and the
prices of assets that can be used as collateral. Changes in bank creditors’ and bank shareholders’ perception of the riskiness of their investments changes the pattern of credit supply. The export payment process involves financial institutions such as banks and insurance companies, where the risk is shared with the exporter. The higher repayment probability from exporters makes lenders more confident about them.

In this essay a monopolistic competition model with heterogeneous firms is used in order to explain the growth of domestic credit targeted at the private sector following trade liberalization in sub-Saharan Africa (SSA). The model indicates that with trade liberalization, the cut-off threshold to enter the export market falls. Briefly trade liberalization policy has the following outcomes:

a) It lowers the marginal cost of production for existing exporters by reducing trade related costs

b) It lowers the cut-off threshold of productivity for firms in the export market

Firms can further lower the marginal cost of production if they decide to upgrade to a higher level of technology of production (Schmidt, 2010). However, with imperfect credit markets, firms still require access to finance to meet the higher fixed costs associated with export markets. Specifically firms need credit to access frontier-level technology to improve their productivity draw and to meet the foreign market fixed costs (Bustos, 2011). A review of this situation indicates that, with an increase in demand for credit by entrepreneurs it appears more lucrative for creditors to invest in such exporting or potential exporting firms.
In this essay, we attempt to estimate the elasticity of domestic credit growth due to opening up of the economy. We use country-level macroeconomic data as an aggregate of firm-level microeconomic data to establish the correlation between trade liberalization and domestic financial sector growth. This approach follows Imbens and Lancaster (1994). In addition, we substantiate our analysis by using their suggested robustness checks. In developing countries, the decision to reform trade policy is often taken in response to commitments made to organizations such as the World Trade Organization (WTO) or the International Monetary Fund (IMF) etc. (Greenaway et al., 2002), so that the causality moves from market opening to growth of the financial sector. In the current essay we have identified the countries located in the SSA region. Besides data availability issues, the choice of SSA has been made for several reasons which include recent policy episodes of opening up of the economy and presence of financial constraints in the economy.

Analysis of data shows that over the period 2000 to 2011, the region experienced increased trade liberalization which helps in testing the hypothesis we set up for the current study. In a recent report by International Finance Corporation (IFC, 2013), lack of access to finance has been declared as the key constraint on the growth of small and medium-sized enterprises and thereby an important limitation on employment and economic growth in SSA. This is despite the fact that SSA has experienced phenomenal growth of private credit during the last decade. Several empirical studies looking for the determinants of credit growth have been conducted. A review of such studies indicates that even with varying approaches, there is a set of common variables which is
statistically significant in determining the factors causing growth of domestic credit. However, due to lack of any specific theoretical model and econometric estimation issues such as endogeneity of explanatory variables, presence of autoregressive correlation between panels etc., the validity of these analyses is generally considered limited and region-specific.

In this essay we find the interesting result that the cost of credit has an overwhelming effect on the growth of domestic financial resources. However, it is reassuring to find that once this limitation is eliminated to achieve capital financing as envisaged under the Modigliani–Miller (1958) theorem, the significance and impact of trade liberalization in stimulating financial growth is restored.

In the following sections we present a brief motivation for the current research, a review of the relevant literature, the theoretical model used for setting up the hypothesis and the empirical estimations. A discussion of results and conclusion mark the end of the current essay.

2. Research Motivation

The modelling approach used in this research is driven by two main objectives. We aim to analyze the interaction between trade reform and growth of the domestic financial sector, keeping in consideration the significance of firm-level heterogeneity and also to ensure a strong microeconomic basis for use with the country level macro data. Following Melitz (2003), international trade models often use firm-level heterogeneity to explain productivity differences between exporters and non-exporters. The available literature also indicates that financial constraints vary across firms and the extent of the
constraint depends on the export market participation of firms, see for example, Greenaway et al. (2007), and Rajan and Zingales (2003). Keeping in mind our first objective, we intend to establish whether trade liberalization has an impact on the future expected revenue earnings of firms, and also if the domestic financial sector responds to such opportunities. Finally we want to determine if credit constraints, measured through the cost of credit, are binding on credit demand in the domestic market.

The hypothesis set up in this essay to test the causality between trade reform and the resultant domestic financial sector growth is in line with Hauner and Prati (2008) who show that trade reform tends to lead to domestic financial reform. Figure 3.1 shows the mean trend for SSA countries for domestic credit and trade for the private sector over the period 2000-2011.

3. Literature Review

In traditional international economic models, lowering trade barriers leads to increased value in total production of the economy. Compared to autarky, trade generates a static improvement in output but it does not cause any technological or economic growth. In other words, openness improves allocative efficiency of the economy. In the Ricardian model, as trade becomes more liberalized, a country specializes in the production of the good(s) in which it has a comparative labor productivity advantage. In the Heckscher-Ohlin model, a country exports the good which uses its relatively abundant factor more intensively. As the economy opens, there is a shift in resources toward the sector that draws upon the abundant factor of production and the value of total production increases. Some of the recent trade models incorporating economies of scale under monopolistic
competition show an increase in total output, following a movement from autarky to free trade, see, for example, Krugman (1979).

Similarly in models of economic growth, trade does not have a clear effect on the rate of growth. In neoclassical models of growth for closed economies, such as the Solow (1956) model, the steady-state rate of growth of output is completely exogenous, and it is equal to the rate of growth of the input that grows exogenously in addition to the equally exogenous rate of technological progress. One exception to these models is the Harrod–Domar model (Harrod, 1939; Domar, 1946), where trade liberalization, i.e., moving the economy to free trade from autarky, has positive growth effects (Srinivasan, 1999). Another kind of model that uses trade to avoid diminishing returns on capital in models of growth is presented in Grossman and Helpman (1991). The authors study a small economy that invents non-traded intermediate goods that are used to manufacture two final goods, which are internationally traded at exogenous world prices. In their framework, trade has direct as well as indirect effects. The direct effect enhances growth and is characterized by the spread of information from foreign sources. The indirect effect refers to the influence of trade on domestic factor markets.

Extensions of the Solow model, for example by Baldwin (1992), show that opening the economy to free trade from autarky has only temporary effects on the growth rate of output; as the economy converges to its free-trade steady state, the growth rate of output converges to its autarky steady-state value. Trade, in this case, has a level effect as the value of output at the new steady state is higher than in autarky.
The theoretical model used in this essay is related to two main strands of the literature. The first concerns reallocation in the economy caused by trade reforms in the presence of heterogeneous firms as analyzed in an exponentially growing theoretical and empirical literature based on the model of Melitz (2003). In such models trade liberalization shifts investment and enhances demand for labor in the relatively more productive sectors of the economy. As labor supply in the economy is fixed, this causes a rise in the minimum productivity of producers, with production concentrated in higher productivity firms and thus results in an increase in mean productivity level. This re-allocative process envisaged in the theoretical models is supported in empirical studies such as that by Bernard et al. (2007) for the US and Pavcnik (2002) for Chile. The second thread of relevant literature concerns the re-allocative effects of financial sector reforms. Theoretical models, such as Almeida and Wolfenzon (2005) and Caselli & Gennaioli (2006), illustrate how domestic financial reforms supported through strengthened legal provisions in areas such as contract enforcement or investment protection, can improve aggregate productivity by reallocation of resources to comparatively more productive firms. The theoretical literature is supported by empirical studies, such as Galindo et al. (2007) and Abiad et al. (2007), showing the favorable impact of financial sector reforms on allocative efficiency.

Based on the above two strands of literature the focus of this essay is on the impact of trade reform on the growth of the domestic financial sector and hence the financial standing of exporting firms. Rajan and Zingales (2003) have contributed by pointing out the role of economic openness in financial development. They stress the role
of trade and financial openness in reducing the influence of interest groups that oppose financial development. In a closed economy, incumbent firms benefit from high degree of trade and financial regulation as it denies potential competitors the opportunities to enter the market. Foreign entry in the domestic goods market reduces rents and creates more investment needs for incumbents to counter competition and take advantage of new opportunities. Greenaway et al. (2007) show that, being an exporter improves a firm’s liquidity. In terms of causality, Greenaway et al. show that improvement in financial health is on account of exporting by the firm.

Another area of the literature concerns the impact of financial constraints on trade. An early paper in this area was by Kletzer and Bardhan (1987) who highlight the influence of financial institutions on comparative advantage. Recent empirical papers, using sector-level data, such as Beck (2003) and Manova (2013), emphasize that credit constraints are a significant determinant of the export decision and hence direction of trade flows. With the trade literature relying more on heterogeneous firm models, several recent papers for example Chaney (2005), Manova, have used this framework to analyze the role of financial frictions in determining export patterns.

The empirical estimation of the hypothesis developed in this essay is conducted using macroeconomic data for SSA. SSA has enjoyed a period of sustained, robust economic growth since the mid-1990s (IMF, 2008). The acceleration of growth occurred alongside an even more rapid development of the financial system in the region. A closer look at the data shows that, across all SSA countries, the median growth rate of real domestic credit to the private sector began to accelerate in 2002. Credit supply is often
driven by the profit-maximizing behavior of banks. Banks expand their credit portfolios as long as lending operations are expected to yield a rate of return on equity that is above the opportunity cost of shareholder funds. With trade liberalization, firms are expected to earn higher profits from foreign market operations which makes extending loans a feasible investment.

This essay contributes to the existing literature on the positive externalities of trade liberalization in a number of important ways. First, the focus here is on a general equilibrium macroeconomic analysis of the interaction of trade and financial development rather than solely examining the role of credit constraints in determining selection decisions into exporting. Second, in line with the empirical evidence, we analyze two-way interactions between exporting and credit markets, i.e., exporting decisions play a role in the financial growth while credit constraints in turn influence the decision of whether to export.

4. Model
The theoretical model used in this essay is a slightly modified version of Taylor (2010) which uses the framework of Melitz along with the credit supply-demand model of Catão (1997). We further relax the assumption of a single production technology and hence incorporate the possibility of variation (increase) in productivity which, by lowering marginal cost, increases expected profits.

Model Framework
There are two economies in the model, home and foreign, who can trade goods. The main feature of the model is the set of heterogeneous firms in each economy who along a
productivity continuum produce a set of varieties of the substitutable goods with labor as
the sole factor of production. As in the framework of Melitz, once an entrepreneur has
incurred the sunk cost of entry, they draw their idiosyncratic productivity. Depending on
its idiosyncratic productivity, the entrepreneur then chooses either to exit the market or to
produce for the domestic market or to incur additional fixed costs of accessing export
markets. However, in the case of countries with imperfect credit markets, the
entrepreneur’s investment decision is subject to credit constraints. It is at this juncture
that we find the link between firms’ production decisions based on domestic financial
conditions and international trade.

Agents in each country may access the domestic credit markets to enter single-
period risk-free debt contracts (assuming zero default in equilibrium). Borrowing against
one unit of the home consumption good from domestic lenders at time \( t \) entails a gross
repayment of \( R_{t+1} \) units of the home consumption good at time \( t + 1 \).

Recovering repayments of the pledged amounts may involve costs to the domestic
creditors. These cost may arise due to the \textit{ex post} moral hazard as explained in Aghion \textit{et al.} (1999) or due to expropriation in the case of \textit{ex ante} moral hazard as shown by Aoki \textit{et al.} (2006). The presence of such financial frictions, negatively affect an entrepreneurs
borrowing prospects. We make the following two assumptions relating to production for
domestic and foreign markets.

\textit{Assumption 1:} Creditors in the home economy can recover a fraction \( 0 < \theta \leq 1 \) of
the domestic output which has been pledged to them by a home entrepreneur;
Assumption 2: The recovery rate on export output pledged to a domestic creditor is a fraction $\mu$ times the recovery rate on domestic output, with $\mu \theta \leq 1$.

Assumption 2 is motivated by the firm-level empirical evidence from emerging and developing economies of the linkage between exporting and credit constraints. On the one hand any additional organizational or informational problems in recovering exports may reduce the relative ability of a creditor to recover exports compared to domestic output. However, on the other hand, certain institutional features, such as involvement of insurance companies, could affect in the opposite direction thereby increasing the relative recovery rate on exports. Thus we allow $\mu$ to take values greater than or less than one, subject to the restriction that the export recovery rate is bounded by unity.

Using the above two assumptions we can write the expected repayments in time $t+1$ against the credit amount of $C_t$ at time $t$ as follows:

$$R_{t+1}C_{t+1} \leq \theta \pi_{d,t+1}(\varphi_{t+1}) + \mu \theta \pi_{x,t+1}(\varphi_{t+1})$$

(1)\hspace{1cm} R_{t+1}C_{t+1} \leq \theta \pi_{d,t+1} + \mu \theta \pi_{x,t+1}

(2)\hspace{1cm} \text{and as } R_t > 0 ,

$$C_{t+1} \leq \frac{1}{R_{t+1}} \left[ \theta \pi_{d,t+1} + \mu \theta \pi_{x,t+1} \right]$$

(3)

where $R_{t+1}C_{t+1}$ are gross repayments made by the entrepreneur at time $t+1$ of the domestic consumption goods for borrowing $C_t$ at time $t$ and $\varphi_{t+1} \geq \varphi_t$ is the productivity at time $t+1$. The creditor can recover a fraction $\theta$ of the next period’s domestic output by
the entrepreneur. Similarly the creditor can recover $\mu \theta$ times units of the home consumption good, of the pledged export output.

Thus exporting increases the potential output that can be pledged to a creditor but, as detailed, requires additional investment. Using the above framework along with the Helpman et al. (2004) model we look into the dynamics of trade liberalization policy. With trade liberalization, low productivity firms supplying the domestic market exit, whereas the probability of firms with near export market cut-off productivity increases, provided they are able to make the correct investment decisions. Although these investment decisions are financially constrained, the scenario following trade liberalization increases the expectation of profits from firms likely to enter foreign markets.

We now turn to the aggregate econometric model developed by Catão (1997) to test for the short and long run determinants of the credit supply. In the long run, supply of domestic credit can be written as a log linear function of lending capacity and the lending interest rate,

$$C^s = \alpha_0 LC^{\alpha_1} R^{\alpha_2} \varepsilon_s$$

(4)

where $C^s$ is credit supply, $LC$ is lending capacity and $R$ is the lending interest rate.

Also the long run demand for credit is a function of GDP and interest rate as follows:

$$C^d = \beta_0 GDP^{\beta_1} R^{-\beta_2} \varepsilon_d$$

(5)

where $C^d$ is demand for credit and $GDP$ is gross domestic product.
Due to the fact that in the long run both credit supply and demand have to converge, we get in equilibrium:

\[ C^S = C^D = Actual\ Credit \] (6)

To focus on the short run implications of the model we add extra variables that have a short run impact on the supply of credit. We consider that increased demand due to trade liberalization is short-term, and therefore, we add trade openness as a variable in our analysis.

**Hypothesis**

Based on the above theoretical background we develop the following hypothesis to be tested using country-level macro data.

**Hypothesis:** The likelihood of provision of domestic credit to the private sector increases with the policy of trade liberalization.

Viewed from the creditors’ perspective, lending to potential exporters comes with the expectation of higher profits, and hence, we expect a positive sign for the main explanatory variable of trade openness.

5. Econometrics

**Data**

The data used for this study are from the comprehensive list of variables included in the World Bank’s African Development Indicators. We use panel data for the years 2000 to 2011 for the 55 countries listed in Appendix-B. Summary statistics indicating trade as a percentage of GDP, domestic credit to the private sector as a percentage of GDP, GDP per capita, mean tariffs, and interest rates are given in the table 3.1. A nice feature of the
data set is that it comprehensively covers the list of various macroeconomic indicators and hence it makes it convenient to use alternative definitions of the variables to test the validity of results.

Variables

The dependent variable is domestic credit to the private sector as a percentage of GDP. The main explanatory variable is trade openness measured using trade as a percentage of GDP. The control variables include per capita GDP, capital flows as percentage of GDP and Country Policy and Institutional Assessment (CPIA) ratings provided in the World Bank dataset we are using in this essay, to account for the fiscal policy and the financial sector strength, and the interest rate.

Control Variables

In the econometric estimation we use the above mentioned control variables for the following purposes:

a) To account for the impact of size of the economy and growth of domestic credit to private sector we use per capita GDP values.

b) To take into account the effect of fiscal sector institutions strength we use the Country Policy and Institutional Assessment (CPIA) rankings. The CPIA is a diagnostic tool that is intended to capture the quality of a country’s policies and institutional arrangements i.e., its focus is on the key elements that are within the country’s control, rather than on outcomes (such as growth rates) that are influenced by elements outside of the country’s control. More specifically, the CPIA measures the extent to which a country’s policy and institutional framework
supports sustainable growth and poverty reduction, and consequently the effective use of development assistance.

c) To control the openness of capital account we use capital flows measured as percentage of GDP

d) To control for the credit supply in response to changes in the rate of return we add interest rates in the equation. Moreover, interest rates act as one of the quantifiable measure of credit constraints existing in the economy besides other availability and regulatory constraints.

6. Econometric Estimation

To test the hypothesis outlined from our model we use the following fixed effects regression equation:

\[ DCPS_{it} = \beta_0 + \beta_1 Trade_{it-1} + \beta_2 R_t + \beta_3 Z_{it} + \text{Country}_i + \epsilon_{it} \]  \hspace{1cm} (7)

where \( DCPS \) is domestic credit to the private sector, \( Trade \) is a proxy for openness of the economy and is the main explanatory variable, \( R \) is the interest rate, \( Z \) are set of remaining control variables and \( \epsilon \) is the idiosyncratic error term. The subscripts \( i \) and \( t \) are used to denote the country and year of the observation.

Simulating Interest Rates- Hypothetical Scenario

To test for the impact of interest rates on domestic credit supply, we simulate hypothetical interest rates such as in Sharpe and Suarez (2014), within the range [3, 5] which are generally observed for developed countries. Limiting interest rates within this range shows that the policy of trade liberalization becomes statistically significant as a determinant of domestic credit supply. This approach confirms that the cost of credit is a
limitation imposed on credit supply through monetary policy and whenever this cost is exorbitant, opening up the economy may not yield the desired results.

_Econometric Concerns_

The main econometric concern in the estimation of equation (7) is the presence of autoregressive correlation between the panels. To check for autocorrelation we use the Wooldridge (2002) test by using the methodology proposed by Drukker (2003). The rejection of the null hypothesis confirms the presence of autocorrelation in the panel data. To correct for the autocorrelation we apply the Prais-Winsten (1954) method that uses the generalized least-squares (GLS) method to estimate the parameters in a linear regression model in which the errors are serially correlated. Specifically, the errors are assumed to follow a first-order autoregressive process.

7. Results

The regression results for equation (7) for the fixed effects regression and GLS are reported in columns (1) and (2) of the table 3.2. Our main variables of concern are trade openness and interest rates. Both the fixed effects and GLS regressions show that trade openness variable is insignificant. The simulation exercise results are shown in table 3.3 where we find that trade openness is positive and significant once the interest rates are restricted within a given range.

_Robustness check_

To confirm the validity of results, we use the generalized method of moments (GMM) estimator as suggested by Imbens and Lancaster (1994). Use of variables such as GDP per capita, trade as percentage of GDP etc. in the regression analysis raises some
endogeneity concerns. To address these, and to confirm the validity of the results, Method of Moments are estimated using Generalized (GMM) dynamic estimator based on the Arellano-Bond methodology. The Arellano-Bond (1991) methodology specifies a dynamic model which allows for time-invariant country-specific effects. The following equation is estimated:

$$\text{DCPS}_{it} = \beta_0 + \beta_1 \text{DCPS}_{i,t-1} + \beta_2 \text{Trade}_{i,t-1} + \beta_3 \text{Z}_{i,t} + \text{Country}_i + \varepsilon_{it}$$

(8)

Results are shown in the column 3 of the tables 3.2 and 3.3. It can be seen that there is no change in the earlier estimation results.

Another concern is the likelihood of multi-collinearity between variables, GDP per capita and Trade as percentage of GDP which makes the specifications difficult to interpret. Other researchers such as Walsh and Yu (2010) have addressed this by establishing a baseline specification to control for important macroeconomic effects, and then adding each of the qualitative variables in turn, which is the approach used in this research. Following this approach we also counter checked our earlier results and found no specific variation.

8. Conclusion

Is liberalizing trade a sufficient stimulus to set off an increase in the supply of domestic credit to the private sector? To answer this, we analyzed macroeconomic data for SSA for the years 2000-2011. The data apparently looks promising in favor of opening up of the economy, showing increase in supply of credit to private sector and volume of trade along with lowering of mean tariff rates. The theoretical model used in this essay also
suggests that trade does generates demand for credit. Although credit demand is the prime driver of financial development, however it is necessary to establish any causality. The theoretical model also shows that cost of credit that is interest rate is can be a significant deciding variable.

In this essay we find that economic policy reform does not lead alone to financial development unless the hurdles imposed by monetary policy are not removed. The findings of the research are significant on two accounts; first trade openness has not been explicitly considered as a prime determinant of domestic credit growth in earlier studies and second it establishes the presence of financial constraint in developing economies. In this essay, we have hypothesized and tested an extension to the theory that by shifting the relative costs and benefits for incumbent firms, trade liberalization may induce positive effects on financial market growth as stipulated by Rajan and Zingales (2003). In doing so we have for the first time examined the sequencing of trade and domestic financial liberalization for an encompassing country panel data set for sub-Saharan Africa. Our findings conditionally support the primacy of trade implied by Rajan and Zingales theory: trade liberalization is a significant leading motivator of domestic financial development provided monetary policy also undergoes reforms. Thus opening up the economy along with domestic financial reform will ensure the diversion of domestic resources to the most productive enterprises.
9. Figures and Tables

Figure 3.1: (a) Domestic Credit to Private Sector (% of GDP), (b) Trade as % of GDP
Source: African Development Indicators (2012)
<table>
<thead>
<tr>
<th>Source: African Development Indicators (2012)</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Table 3.1: Summary Statistics</strong></td>
</tr>
<tr>
<td>Mean</td>
</tr>
<tr>
<td>------</td>
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<tr>
<td><strong>Trade as % of GDP</strong></td>
</tr>
<tr>
<td><strong>Domestic Credit to Private Sector(% of GDP)</strong></td>
</tr>
<tr>
<td><strong>(GDP Per Capita)</strong></td>
</tr>
<tr>
<td><strong>Tariff (Mean All Products)</strong></td>
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<tr>
<td><strong>Interest Rates (Lending in %)</strong></td>
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### Table 3.2: Regression Results

<table>
<thead>
<tr>
<th>VARIABLES</th>
<th>FE</th>
<th>GLS</th>
<th>GMM</th>
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<tbody>
<tr>
<td>Trade Openness</td>
<td>-0.00365</td>
<td>-0.114</td>
<td>0.032</td>
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<tr>
<td></td>
<td>(-0.137)</td>
<td>(-0.1566)</td>
<td>(-0.119)</td>
</tr>
<tr>
<td>GDP</td>
<td>0.782***</td>
<td>0.284***</td>
<td>0.220**</td>
</tr>
<tr>
<td></td>
<td>(-0.0828)</td>
<td>(-0.0829)</td>
<td>(-0.0873)</td>
</tr>
<tr>
<td>CPIA Fiscal Ranking</td>
<td>0.150***</td>
<td>0.174***</td>
<td>0.0721</td>
</tr>
<tr>
<td></td>
<td>(-0.0558)</td>
<td>(-0.0485)</td>
<td>(-0.0512)</td>
</tr>
<tr>
<td>Interest Rate (%)</td>
<td>-0.0259</td>
<td>-0.0958</td>
<td>-0.00358</td>
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<tr>
<td></td>
<td>(-0.0749)</td>
<td>(-0.0597)</td>
<td>(-0.0647)</td>
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<tr>
<td>Constant</td>
<td>-2.93***</td>
<td>0.819**</td>
<td>-0.803</td>
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<td></td>
<td>(-0.849 )</td>
<td>(-0.41)</td>
<td>(-0.698)</td>
</tr>
<tr>
<td>Observations</td>
<td>207</td>
<td>207</td>
<td>169</td>
</tr>
<tr>
<td>R-squared</td>
<td>0.394</td>
<td>0.953</td>
<td></td>
</tr>
</tbody>
</table>

*Notes: *Significant at 10% level, **significant at 5% level, and *** significant at 1% level
Table 3.3 Regression Results

<table>
<thead>
<tr>
<th>Variable</th>
<th>Fixed Effects</th>
<th>GLS</th>
<th>GMM</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>(1)</td>
<td>(2)</td>
<td>(3)</td>
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<tr>
<td>Trade Openness</td>
<td>0.337***</td>
<td>0.195**</td>
<td>0.172***</td>
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<td></td>
<td>(-0.111)</td>
<td>(-0.081)</td>
<td>(0.067)</td>
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<tr>
<td>GDP</td>
<td>0.735***</td>
<td>.303***</td>
<td>0.203***</td>
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<tr>
<td></td>
<td>(-0.0731)</td>
<td>(-0.0907)</td>
<td>(0.039)</td>
</tr>
<tr>
<td>CPIA Fiscal Ranking</td>
<td>0.158***</td>
<td>0.107**</td>
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</tr>
<tr>
<td></td>
<td>(-0.0531)</td>
<td>(-0.0435)</td>
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<tr>
<td>Constant</td>
<td>-4.122***</td>
<td>5.301***</td>
<td>0.878***</td>
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<tr>
<td></td>
<td>(-0.72)</td>
<td>(-0.828)</td>
<td>(0.366)</td>
</tr>
<tr>
<td>Observations</td>
<td>242</td>
<td>203</td>
<td>331</td>
</tr>
<tr>
<td>R-squared</td>
<td>0.364</td>
<td>0.099</td>
<td></td>
</tr>
</tbody>
</table>

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


Emerging markets information service: (EMIS). New York: Internet Securities accessed via Ohio State University Library.


Monck, C. 2010. Performance monitoring and evaluation, UKSPA conference proceedings

National Statistics, Directorate-General of Budget, Accounting and Statistics Executive Yuan (DGBAS), Taiwan (2010)


Appendix A

Complete Derivation of Credit Demand

Firm pricing rule in home market: \( p_h = 1 / \rho \phi \)

Firm pricing rule in foreign market: \( p_f = \tau / \rho \phi \)

Firm profits from home market: 
\[
\pi_h(\phi^T) = \left( \frac{E}{\sigma} \right) (P \rho \phi)^{(\sigma - 1)} - f \quad \text{(from Melitz, 2003)}
\]

Firm profits from home and foreign markets:
\[
\pi_h(\phi^T) + \pi_f(\phi^T) = \left( 1 + \tau^{1-\sigma} \right) \left( \frac{R}{\sigma} \right) (P \rho \phi)^{(\sigma - 1)} - \eta f - f_x
\]

E=aggregate expenditure and P= aggregate price

Now we have \( \phi = \left[ C(\phi_0,.) \right]^{\sigma} \phi_0 \) so

\[
\delta \left\{ \Pi \left( \frac{M}{\phi^M_H} \right) \right\} / \delta \left\{ C(\phi^T,.) \right\} = \delta \pi_f (\phi^{M/H}_f) / \delta \left\{ C(\phi^T,.) \right\} + \delta \pi_h (\phi^{M/H}_h)
\]

\[
/ \delta \left\{ C(\phi^T) \right\} - \delta [R(\phi^T_c)C(\phi^T_0)] / \delta \left\{ C(\phi^T,.) \right\} = 0
\]

\[
E \left[ \frac{P\phi_0}{\tau} \right]^{\sigma-1} \alpha \left[ \frac{\sigma - 1}{\sigma} \right]^{\gamma - \sigma} \left[ l \phi_0 \right]^{\beta} = p_1 E(\phi_0)
\]

\[
C(\phi^T,.) = (E\alpha)^{\frac{1}{\beta} \left[ \frac{\sigma - 1}{\sigma} \right]^{\frac{\beta}{\sigma}} \left[ P\phi^T_0 \right]^{\frac{\sigma - 1}{\beta}} \left[ \frac{1}{1 + \tau^{1-\sigma}} \right]^{\frac{1}{\beta}} \left[ \frac{1}{E(\phi^T_0)} \right]}
\]
Appendix B

List of Countries

<table>
<thead>
<tr>
<th>Algeria</th>
<th>Mali</th>
</tr>
</thead>
<tbody>
<tr>
<td>Angola</td>
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<tr>
<td>Benin</td>
<td>Mauritius</td>
</tr>
<tr>
<td>Botswana</td>
<td>Morocco</td>
</tr>
<tr>
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<td>Burundi</td>
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<td>Cote d'Ivoire</td>
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<td>Egypt, Arab Rep.</td>
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