Essays in International Trade and Financial Development

by

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Dedication

To my family:
Mom, at once my exemplar and my core
Dad, who set the bar sky high
Grandpa, my intellectual hero
Grandma, who awaited so patiently
And the rest of the bunch, who kept me from getting lost

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Preface

In the first chapter, I explore the effect of intellectual property rights (IPRs) on the composition of international trade. Conventional wisdom and theory have it that developing countries' IPRs incentives differ substantially from those of developed countries, especially under technology imitation. The model I develop here explores a new channel by which IPRs may affect welfare such that cross-country incentives are aligned even in the short run: the composition of trade. I investigate whether and how IPRs and the threat of imitation may affect trade of differentiated products asymmetrically. Allowing for differing consumer preferences across products implies unique markups and demand elasticities for all differentiated goods. Because products are associated with different profit potential, firms make asymmetric export decisions when faced with the threat of imitation and its spillover effects into the home market. Cross-country incentives can be aligned as product imitators trade off gains from lower prices with losses due to less access to inelastically demanded varieties. The primary predictions of the model find empirical support in the data, where it is shown that a greater proportion of inelastically demanded goods are exported to stronger relative to weaker IPR destinations.

In the second chapter, joint work with William F. Lincoln (Johns Hopkins University), we ask the question: how do intellectual property rights (IPR) policies affect international trade? We consider two of the central results from the model presented in Chapter I: (i) that IPR reforms should expand the range of goods exported to a country through the extensive margin of trade and (ii) firms with more newly developed products should be more sensitive to IPR policies than other innovative firms. Building the first comprehensive matched firm-level data set on destination-specific exports and patents, we begin by documenting a number of facts on the relationship between trade and innovation. We then document a significant positive relationship between whether or not a firm has a patent and its sensitivity to IPR policies in terms of its exports. Firms with more newly developed patents show a larger sensitivity than other firms.

Finally, in the third chapter, joint work with Yibin Mu (International Monetary Fund), I analyze financial development in Sub-Saharan Africa. The financial sectors of Middle-Income

Countries (MICs) in Sub-Saharan Africa (SSA) continue to evolve. Under this backdrop, this chapter investigates two questions: (1) how does financial inclusion compare to a group of emerging economies and (2) how does financial inclusion impact financial stability? Our findings suggest the following: (i) access to finance for individuals in SSA is comparable to EMs while access to finance for SMEs lags behind EMs; (ii) SME access to finance and/or savings-oriented financial inclusion enhances financial stability while financial inclusion focusing on credit to individuals undermines financial stability; and (iii) a more equity and deposit based funding structure enhances financial stability.

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Chapter 1

Trade of Differentiated Products Under Intellectual Property Imitation

1.1 Introduction

The traditional discussion around intellectual property right (IPR) protection centers on the time-inconsistency problem of conflicting short-run price versus long-run innovation incentives. A similar trade-off exists between developed nations, the source of most technological innovation, and developing nations who seek greater accessibility of innovative products. Developing nations have often relied on varying degrees of product imitation as a de facto economic development strategy in a bid to "catch-up" to advanced economies. It is common to assume incentive misalignments between developed nations seeking stronger IPRs versus developing nations which seek lower protection[1], as highlighted by the discussion surrounding the WTO Trade Related Aspects of Intellectual Property (TRIPs) agreement. How is the composition of trade affected by IPRs? Can a country with weak IPRs ever lose in the short run from technology imitation? It is to these questions that this paper is addressed.

In the new trade theory with increasing returns to scale, product variety has important implications for the gains from trade. In these models, welfare gains stem from increasing access to the number of product varieties, founded upon consumers' taste for variety. Yet, the varieties each contribute equally to consumer welfare under the standard CES utility assumption and there is no differential weight due to the type of variety itself. Faced with potential shocks to profit, such as those due to intellectual property (IP) pilferage, firms of comparable productivity should adjust in the same way given CES preferences between

[1] Grossman and Lai (2004) demonstrate this misalignment theoretically in a game-theoretic framework.

varieties. A fundamental question, then, is whether it is indeed the case that shocks such as the threat of IP piracy affect firm exports of different varieties in the same way. In this paper, I explore this question both theoretically and empirically.

I develop a North-South theoretical framework of firm export choice under IP piracy when consumer preferences differ across varieties. To fully incorporate the idea of individuals having differing tastes over a spectrum of varieties, I drop the oft-used CES utility function in favor of a quasi-linear utility with varying preference parameters for each variety. The distinct preference parameters translate into goods associated with unique markups and own-price demand elasticities. The Northern firm export decision is fully endogenized as a trade-off between gains from a larger consumer market and losses from potential piracy of its technology by Southern firms. The model hinges on the fact that firm profits are higher for more inelastically demanded goods. Thus, when faced with the threat of product piracy with spillover effects into the home market, firms producing relatively inelastically demanded goods stand to sustain greater profit losses and are more sensitive to destination market IPRs. This leads to systematically different firm export decisions across products.

An important insight the model delivers is that exports of varieties can differ in the extent to which they are affected by destination IPRs. Exports of relatively homogeneous, highly demand elastic goods are entirely unaffected by the presence of IP piracy. This is because Southern firms either already have the technology to produce the most homogeneous variety or imitation is not profitable. If a variety is highly demand inelastic, however, firm profits for that good are higher and the threat of technological imitation can be a binding constraint for exports. In the model, accessing the South via exports leads to a greater risk of IP piracy, which cuts into profits both at home and abroad. However, this is offset by potential profits gains from selling in the South, which is proportional to the population share of the South. In equilibrium, if the share of the South's population is greater than the increased probability of piracy, then trade is not affected and firms will choose to export as gains from accessing a larger market more than offsets expected losses from piracy.

While there exist several important papers in the theoretical literature on trade with technological imitation, this paper is most closely related to Connolly and Valderrama (2005), which showed that technological spillovers in a model with intermediate goods and imitation can result in properly designed Southern IPR regimes that are welfare-enhancing for both the developed North and the developing South. The primary departures I make from the existing literature are: use of preferences allowing for differing demand elasticities across goods, the presence of explicit firm profit shocks stemming from technological imitation and a focus on short-run impacts rather than the traditional long-term feedback effects on innovation. In this sense, the model can offer short-run incentive compatibility for both trading partners and can flexibly generate positive or negative net gains from trade dependent upon destination country size and IPR regime.

The predictions of the theoretical model find strong empirical support. Using country-product-level world bilateral trade data, I document several new empirical regularities that are consistent with the theoretical framework. In the data, there is greater trade of relatively inelastically demanded products to strong compared to weak IP protection destinations. I find this to be the case both cross-sectionally across countries with differing levels of IPRs and across time for the same country following a number of well-documented IP reforms. This finding also holds under various specifications and sensible subsample checks. This suggests not only that trade of varieties is differentially impacted by the threat of IP piracy, but that differing consumer preferences across these varieties may generate an additional channel through which trade under IP piracy affects welfare, beyond the standard number of varieties effect.

In the empirical section, I evaluate the effect of IPRs on the composition of import varieties in several ways. First, I take a cross-sectional difference-in-difference approach utilizing Park (2008) indices on IPR strength across countries. I use Broda-Weinstein country-specific estimated demand elasticities (σ's) at the HS 3-digit level as a measure of product differentiation. Combining these, I estimate the effect of the interaction between product elasticities and IPRs, controlling for product and bilateral country fixed effects. I also run a number of robustness checks, detailed in the empirical section. Results across all specifications significantly point to the fact that more inelastically demanded goods are more likely to be exported to a destination with stronger IPRs. The magnitudes range from a .447% to 3.2% higher import value of inelastically demanded goods for every one standard deviation decrease in elasticity between countries with the strongest versus weakest IPRs.

I also estimate a panel difference-in-difference model for 6 individual countries well-documented as having had IPR reforms (Branstetter et. al 2006): Argentina, Brazil, China, Colombia, Turkey and Venezuela. I use destination-specific product demand elasticities interacted with a binary reform variable to look at the trade impact on different varieties from the reform for each country individually. I then pool together data from all 6 reforms and rerun the estimation. I find that the signs of the coefficients are broadly consistent with the cross-sectional evidence, but that this effect is only significant in the pooled-sample. The coefficient signs suggest, altogether, that relatively inelastically demanded goods are more likely to be exported to a destination following an IP reform.

The paper proceeds as follows. In Section 2, I set up the baseline theoretical model and highlight some important features of the model. Section 3 explores the closed economy solution and includes some comparative statics. Section 4 explores the open economy solution with corresponding welfare analysis and comparative statics for both countries. In Section 5, I extend the baseline model to incorporate endogenous IP piracy and incomplete re-exportation. Section 6 presents empirical evidence. Section 7 concludes.

1.2 A Model of Firm Exports and Trade under IP Piracy

I develop a short-run model of firm export choice under intellectual property imitation. Despite lack of direct exploration of the effect on exports of potential IP piracy, the existing New Trade Theory literature, based almost exclusively on CES consumer preferences, does have something to say about this issue. If the risk of IP piracy were to become non-zero, the standard Melitz model based on CES preferences with its constant markup would see the overall number of varieties traded decrease. But this decrease would be symmetric across all varieties, given the same level of firm productivity, and there would be no reason to expect products of different varieties (much less different elasticities, since all elasticities are the same) to be impacted differentially in the face of varying IPR levels or following an IP reform. As a result, any welfare consequences would be dependent only upon the number of varieties (as differentiated based on firm productivity, not preferences) and not the type of varieties consumers prefer.

In this model, I abstract from firm productivity differences except for those that are cross-country and between homogeneous and differentiated varieties. Instead, I focus on differences in consumer preferences over types of varieties and explore whether and how this dimension generates varietal differences in firm export choice under the threat of IP pilferage. Differences in firm export choice across varieties can stem from differing profits across products due to the varying demand elasticities of the products. Welfare impacts under this framework are then considered for both parties to trade.

1.2.1 Model Setup

There are 2 types of countries in this model: the high-wage developed (North) and the low-wage developing (South) countries. Labor is the only factor of production with labor productivity differing in the two countries, while the labor force in both countries is assumed to be fixed and exogenous at L_N and L_S, respectively. The North has the unique ability to produce differentiated goods from its exclusive innovative ability, while South is unable to develop new goods. The homogeneous goods is tradable and its technology is common property, so that it can be produced in either North or South, though with differing productivity, as discussed later. I assume that the market for the homogeneous good is characterized by perfect competition in both countries.

Let J be the total number of "new" goods currently produced that are still under an active patent. Over time, the set of J changes via a law of motion governed by both Northern innovation and IPR protection, but I abstract from dynamic considerations and focus on short-run effects under a fixed J. Within this framework, we can interpret the products either as different goods altogether or simply as different varieties of the same good. To keep in line with the data in the empirical section, I choose the former interpretation in this treatment; however the latter interpretation holds equal merit within this framework.

1.2.2 Consumer Optimization

Let there be a continuum of new goods varieties $j \in [1, J]$. Each economy has measure 1 number of consumers. Each variety is associated with a distinct preference parameter $\theta_j > 1$, with $\theta_j \in (1, \infty)$, which will imply differing own-price elasticities of demand for each good type. Intuitively, this can be thought of as the existence of many assortments of a good, with each differing in its own-price demand elasticity. In this formulation, as I show below, higher values of θ_j always correspond to goods associated with relatively inelastic demands, which can be interpreted as "newer" goods. Without loss of generality, I will also assume that θ_j is monotone increasing in j, that is, goods j are ordered by decreasing demand elasticity. Homogeneous consumers share the same quasilinear instantaneous utility function[2]. Good 0 is the homogeneous numeraire. Consumers in both countries have similar preferences and solve the instantaneous maximization problem

$$\begin{aligned} \max u &= q_0 + \int_1^J \theta_j q_j^{\frac{1}{\theta_j}} dj \\ \text{s.t. } I &= p_0 q_0 + \int_1^J p_j q_j dj \end{aligned}$$

Setting p_0 to unity, as the numeraire, the solution is given by

$$\begin{aligned} q_j &= p_j^{\frac{\theta_j}{1-\theta_j}} \\ q_0 &= I - \int_1^J p_j^{\frac{1}{1-\theta_j}} dj \end{aligned}$$

[2] The usage of quasilinear preferences has precedence set in the literature including Dixit and Norman (1980), Grossman and Helpman (1994), Ottaviano et al. (2002, quadratic quasi-linear), Melitz and Ottaviano (2008, quadratic quasi-linear) and Dinolopoulos (2011). Other specifications allowing for differing demand elasticities across goods would likely yield similar results, but in this paper I employ the simplest possible utility function with this feature.

with each good j's corresponding own-price elasticity of demand given by

$$\sigma_{p_j}^D = \frac{\theta_j}{1-\theta_j},\ \theta_j > 1$$

This implies that varieties corresponding to higher values of θ_j have demand that is relatively more inelastic. Higher θ_j in this utility function represents varieties of relatively lower elasticity.

1.2.3 Firm Optimization

The North

Due to the presence of intellectual property right patents, each variety will have only one monopolistic firm producing it. The Northern firm specializing in production of a variety will thus also be indexed by j, with J total firms. Production in each industry is a simple linear function of labor alone. I assume that production for the firm associated with each variety has a unit labor requirement of 1, thus the production function can be represented by $q_j = l_j$, where l_j is labor input into making that variety of the good. Let us also assume that production of the homogeneous good is linear in the North $q_0^N = l_0^N$. Let q_j^N be the per-consumer demand faced by the Northern firm for its product, p_j^N the price it sets for its product and l_j^N its choice of labor input. Firms for each industry enjoy monopoly profits and face the following closed economy optimization problem, with w_N denoting wages in the North:

$$\pi_j^N = p_j^N q_j^N - w_N l_j^N$$

Because all consumer preferences are symmetric, the per-consumer firm profit maximizing conditions in the North are therefore:

$$\begin{aligned} p_j^N &= w_N\theta_j \\ &\Rightarrow q_j = p_j^{\frac{\theta_j}{1-\theta_j}} = (w_N\theta_j)^{\frac{\theta_j}{1-\theta_j}} \\ q_0 &= I - \int_1^J (w_N\theta_j)^{\frac{1}{1-\theta_j}}\, dj \end{aligned}$$

In equilibrium, if the homogeneous good 0 is produced and all production is linear in labor input, then $p_0 = w_N$ and wages in the North should be unity as well. This implies that prices and per-consumer quantities can be expressed as functions of the preference parameter

θ_j:

$$\begin{aligned} p_j^N &= \theta_j \\ q_j &= \theta_j^{\frac{\theta_j}{1-\theta_j}} \\ q_0 &= I - \int_1^J \theta_j^{\frac{1}{1-\theta_j}} dj \end{aligned}$$

The South

For simplicity, I will assume that firms in the South cannot develop new products and are only capable of either producing the homogeneous good or imitating Northern products. I show that there will exist a $\hat{\theta}_j$, below which represents the goods exported by the North to the South and above which represents the goods that remain unexported by North. Let n_S denote the set of products both exported to and imitated by South and let n_N denote the set of goods produced and exported by North and not imitated by South.

In order to match the intuition of the South representing developing countries, I assume that $w_S < 1 = w_N$. This relative wage condition holds by assuming that Southern productivity of the non-traded homogeneous good is lower than its Northern counterpart (i.e. $q_0^S = \gamma_0^S l_0^S$ where the productivity $\gamma_0^S < 1$); otherwise only South would produce the homogeneous good. For the $j \in n_S$ products imitated by South, I assume the imitation was complete and a Southern firm can imitate the good with the same productivity of the originating Northern firm (i.e. $q_j^S = l_j^S \ \forall \ j \in n_S$). This assumption can be easily relaxed and all results would qualitatively go through.

IPRs can be represented by a per-unit expected fine, ϕ, of pirating a Northern product, with higher expected fines associated with stronger IPRs. The per-unit nature of the fine is in line with actual IPR enforcement practices. Expected fines are redistributed back, lump-sum, to North and enters in Northern aggregate welfare. Given that any firm in the South can choose to imitate an imported Northern product, and assuming the homogeneous good is still produced in the South, the market for each imitated variety is perfectly competitive and thus, in the absense of IPR protection, prices in South should equal marginal cost and satisfy $p_j^S = w_S \ \forall \ j \in n_S$. For the unimitated goods $j \in n_N$, prices remain at monopoly prices $p_j^S = p_j^N = \theta_j$. Since the presence of imitation can cause Northern firms to choose not to export certain products to South, I distinguish the total set of products available in the South, i.e. exported by North or produced by South, by denoting this $J^S \subset J$, with $n_S \subseteq J^S$.

The labor market clearing condition in South is given by

$$L_S = \frac{q_0^S}{\gamma_0^S} + \int\limits_{j \in n_S} q_j^S dj$$

where $q_j^S = \left(p_j^S\right)^{\frac{\theta_j}{1-\theta_j}}$ and $q_0^S = w_S L_S - \int_1^{J^S} p_j^S \left(p_j^S\right)^{\frac{\theta_j}{1-\theta_j}} dj$, with $j \in J^S$. Since w_N was pinned down at unity, then if we restrict attention to the case in which the homogeneous good is produced in South in equilibrium, the Southern wage can be determined directly solving the market clearing condition above. In this case, $w_S = \gamma_0^S w_N = \gamma_0^S$.

Timing

Being a static model, the timing of all firm actions happens over a short span in a series of sequential steps. First each Northern firm develops and produces the profit-maximizing quantity of its product for the Northern consumers and observes the probability of being pirated in South. The Northern firm then decides whether or not to export to South. If export occurs, then there is an immediate probability ρ of being pirated by a Southern firm and being forced into Southern perfectly competitive profits, although due to productivity differences this is still above marginal cost for the Northern firm. If its product is pirated, then if the competitive profits are sufficient (which occurs if the technology gap between North and South is very large), a Northern firm will undercut the Souther competitive price by ε, recapturing the market; otherwise the firm will simply exit the market.

1.3 Closed Economy Solution

To begin with, it is helpful to analyze the economic environment in North in autarky. Solving the closed economy equilibirum for North requires budget balance and labor market clearing conditions.

1.3.1 Price Index

The ideal price index in the North (derivation in Mathematical Appendix) is given by

$$\mathbf{P} = p_0 - \int_1^J p_0^{\frac{\theta_j}{\theta_j - 1}} \theta_j p_j^{\frac{1}{1-\theta_j}} dj + \int_1^J p_0^{\frac{\theta_j}{\theta_j - 1}} p_j^{\frac{1}{1-\theta_j}} dj$$

Plugging in the monopoly price $p_j^N = \theta_j$ and normalizing the price of the homogeneous good $p_0 = 1$, we have

$$\mathbf{P} = 1 - \int_1^J \theta_j^{\frac{2-\theta_j}{1-\theta_j}} dj + \int_1^J \theta_j^{\frac{1}{1-\theta_j}} dj$$

1.3.2 Budget Balance

I will assume that at a given point in time the number of goods/industries J is fixed and there is no free entry. This makes intuitive sense due to the presence of patents; once a good is invented, patents prevent other firms from producing that particular variety of good. Noting that price normalization for the homogeneous good implies zero profits for that good, let total firm profits per-capita in North at date t be represented by

$$\begin{aligned} \frac{\Pi_N(t)}{L_N} &= \int_1^J \left[p_j^N q_j^N - w_N q_j^N\right] dj \\ &= \int_1^J \left[\theta_j^{\frac{1}{1-\theta_j}} - \theta_j^{\frac{\theta_j}{1-\theta_j}}\right] dj \end{aligned}$$

Since total income, Υ, equals the sum of labor income and monopoly rents, $\Upsilon = w_N L_N + \Pi_N = L_N + \Pi_N$. Individual income, I, then can be expressed as $I = \frac{\Upsilon}{L_N}$, assuming perfect income equality.

Then budget balance in the North implies that total expenditure, E_N, equals total income and satisfies:

$$E_N = L_N + \Pi_N = L_N + L_N \int_1^J \left[\theta_j^{\frac{1}{1-\theta_j}} - \theta_j^{\frac{\theta_j}{1-\theta_j}}\right] dj = \Upsilon$$

It is important to note here that consumption of the homogeneous good will always be positive as long as $1 > \int_1^J \theta_j^{\frac{\theta_j}{1-\theta_j}} dj$. This places no additional restrictions on θ_j or J.

1.3.3 Market Clearing

In equilibirum, labor supply in North will equal labor demand, the labor required to produce the equilibrium quantity demanded for each Northern good produced. Since Northern production technology is linear for both the differentiated and homogeneous products and the measure of consumers is unity, with all consumers having symmetric preferences, labor market clearing can be expressed as:

$$L_N = I - \int_1^J \theta_j^{\frac{1}{1-\theta_j}} dj + \int_1^J \theta_j^{\frac{\theta_j}{1-\theta_j}} dj$$

This condition, however, is redundant and follows from the budget balance condition due to the fact that the form of utility function implies infinitely elastic labor demand for the homogeneous good. As such, if positive quantities of the homogeneous good are produced, then the wage rate is immediately pinned down and the market clearing condition automatically follows from the goods market clearing condition.

1.3.4 Welfare

Real wages in the North can be represented by

$$\frac{w}{\mathbf{P}} = \frac{1}{1 - \int_1^J \theta_j^{\frac{2-\theta_j}{1-\theta_j}} dj + \int_1^J \theta_j^{\frac{1}{1-\theta_j}} dj}$$

Welfare can be expressed as real wages plus real profits per worker and is given by

$$\mathbf{W} \equiv \frac{w}{\mathbf{P}} + \frac{\frac{\Pi_N}{L_N}}{\mathbf{P}} = \frac{1 + \int_1^J \left[\theta_j^{\frac{1}{1-\theta_j}} - \theta_j^{\frac{\theta_j}{1-\theta_j}} \right] dj}{1 - \int_1^J \theta_j^{\frac{2-\theta_j}{1-\theta_j}} dj + \int_1^J \theta_j^{\frac{1}{1-\theta_j}} dj}$$

1.3.5 Comparative Statics

Looking at the evolution of welfare as the number of products J grows, we can see that the real wage increases in the number of varieties. This result is consistent with new products entering positively into the utility function.

Claim 1 *P is decreasing in J and $\frac{w}{\mathbf{P}}$ is increasing in J*

Proof.

$$\begin{aligned}
\frac{2-\theta_J}{1-\theta_J} \ln \theta_J &> \frac{1}{1-\theta_J} \ln \theta_J, \ \forall \ \theta_J > 1 \\
\Longrightarrow & \quad \theta_J^{\frac{2-\theta_J}{1-\theta_J}} > \theta_J^{\frac{1}{1-\theta_J}}, \ \forall \ \theta_J > 1 \\
\Rightarrow & \quad \frac{\partial P}{\partial J} = -\theta_J^{\frac{2-\theta_J}{1-\theta_J}} + \theta_J^{\frac{1}{1-\theta_J}} < 0 \\
\Rightarrow & \quad \frac{\partial \frac{w}{\mathbf{P}}}{\partial J} > 0, \ \forall \ \theta_j > 1
\end{aligned}$$

■

Looking at how monopoly rents, and thus monopoly rents per worker, are affected by the number of varieties, we have the following claim

Claim 2 $\frac{\Pi_N}{L_N}$ *is increasing in* $J(t)$

Proof.

$$\begin{aligned}
\frac{\Pi_N}{L_N} &= \int_1^J \left[\theta_j^{\frac{1}{1-\theta_j}} - \theta_j^{\frac{\theta_j}{1-\theta_j}}\right] dj \\
\frac{1}{1-\theta_J}\ln\theta_J &> \frac{\theta_J}{1-\theta_J}\ln\theta_J,\ \forall\ \theta_J > 1 \\
&\Rightarrow \theta_J^{\frac{1}{1-\theta_J}} > \theta_J^{\frac{\theta_J}{1-\theta_J}},\ \forall\ \theta_J > 1 \\
&\Rightarrow \frac{\partial\Pi_N}{\partial J} = \theta_J^{\frac{1}{1-\theta_J}} - \theta_J^{\frac{\theta_J}{1-\theta_J}} > 0 \\
&\Rightarrow \frac{\partial\frac{\Pi_N}{L_N}}{\partial J} > 0,\ \forall\ \theta_j > 1
\end{aligned}$$

■

Altogether, this implies that aggregate welfare rises as the number of varieties increases, that is, $\frac{\partial\mathbf{W}}{\partial J} > 0$.

Looking at how monopoly rents per worker for a particular firm j, $\pi_j^N = \theta_j^{\frac{1}{1-\theta_j}} - \theta_j^{\frac{\theta_j}{1-\theta_j}}$, are affected by the elasticity, I make the following claim

Claim 3 π_N *rises with* θ_j, $\forall\ \theta_j > 1$

Proof.

$$\frac{\partial\pi_j^N}{\partial\theta_j} = \left[\begin{array}{c} \left(\frac{1}{\theta_j(1-\theta_j)} + \frac{1}{(1-\theta_j)^2}\ln\theta_j\right)\theta_j^{\frac{1}{1-\theta_j}} \\ -\left(\frac{1}{1-\theta_j} + \frac{1}{(1-\theta_j)^2}\ln\theta_j\right)\theta_j^{\frac{\theta_j}{1-\theta_j}} \end{array}\right] > 0,\ \forall\ \theta_j > 1$$

■

1.4 Open Economy Solution

The framework under an open economy is the main one of interest in later analyzing the empirical evidence. All the firm-level properties explored in the previous section, under a closed economy, follow here with some minor modifications.

1.4.1 Profits

Let q_j^N and q_j^S be the per consumer demand faced in North and South respectively for product j. Under monopoly, $p_j^M = \theta_j$ and $q_j^M = \theta_j^{\frac{\theta_j}{1-\theta_j}}$. Let $\pi_j^M = \left(p_j^M - w_N\right) q_j^M =$

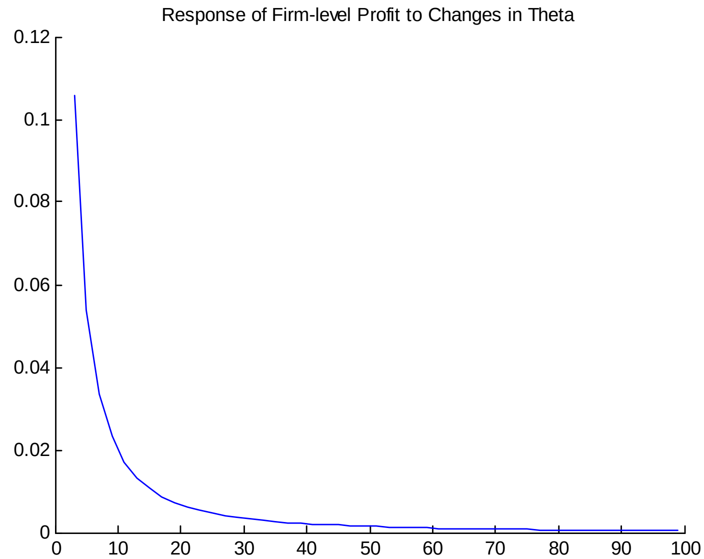


Figure 1.1: Response of firm-level monopoly profits to increases in θ

$(\theta_j - 1)\,\theta_j^{\frac{\theta_j}{1-\theta_j}}$ denote Northern firm level profits per consumer, under monopoly. A Northern firm that chooses not to export its product earns the autarky total profit $\Pi_j^M = \pi_j^M L_N$. A Northern firm that exports its product to South and whose product is not imitated faces the same monopoly price and quantity as under autarky and earns the global profits $\pi_j^N = \pi_j^M (L_N + L_S)$.

Southern firms face a per-unit expected fine ϕ of pirating a Northern product. A Southern firm who chooses to imitate a specific Northern firm's product earns expected profit of zero due to perfect competition in the South. Its expected total profit can be expressed as $E\left(\pi_j^S\right) = \left(p_j^S - w_S - \phi\right)\left[q_j^N L_N + q_j^S L_S\right]$. Therefore under perfect competition, the price of product j in South will simply equal the marginal cost $p_j^S = p^S = w_S + \phi$ and expected profits will be zero for all imitated varieties $j \in n_S$. Southern firms will repeat the game every period and can opt to imitate again even if they were caught previously.

I make the assumption that, if imitated, Northern firms face some spillover effects in the home market. That is, when its product is imitated, a Northern firm not only faces competitive prices in the Southern market, but also sees some of its existing domestic market base subject to competitive prices as well, with affected prices and quantities given by $p^S = w_S + \phi$ and $q_j^C = (w_S + \phi)^{\frac{\theta_j}{1-\theta_j}}$. Let $\omega \in [0,1]$ denote the proportion of Northern consumers that can procure any pirated good j. The case in which $\omega = 0$, then, corresponds to no access to imitated goods by Northern consumers, while

$\omega = 1$ corresponds to full access to pirated products; throughout this analysis, I assume $\omega > 0$. Profits for a Northern firm when its product is imitated will be given by $\pi_j^C = \left(p_j^M - w_N\right) q_j^M (1-\omega) L_N + \max\left\{p_j^C - w_N, 0\right\} q_j^C (\omega L_N + L_S)$. Thus as long as $\omega < 1$ or if the expected fine is big enough on IPR infringement by the South, North can still obtain positive profits even under the presence of piracy.

1.4.2 The North

When the countries open up to trade, each Northern firm must decide whether or not to export its product to South. If a firm exports, it faces an increased probability of its technology being pirated relative to selling purely domestically. This piracy probability differential is given by $\rho = f\left(\pi_j^N, \phi\right)$, where $f_1 < 0$, $f_2 < 0$. Whenever technology is pirated, the firm associated with that variety is forced into a Bertrand game of perfect competition with all Southern imitators of its product. Let π^D be the profit of a Northern firm from selling only to the domestic market and let π^X be the expected profit of a Northern firm from exporting to South and also selling domestically.

$$\begin{aligned}
\pi^D &= \left(p_j^M - w_N\right) q_j^M L_N \\
\pi^X &= \left\{ \begin{array}{c}
\left(p_j^M - w_N\right) q_j^M (L_N + L_S) \\
\text{if } p_j^M \leq p^S \\
(1-\rho)\left(p_j^M - w_N\right) q_j^M (L_N + L_S) + \rho \left[\begin{array}{c} \left(p_j^M - w_N\right) q_j^M (1-\omega) L_N \\ + \max\left\{p_j^C - w_N, 0\right\} q_j^C (\omega L_N + L_S) \end{array} \right] \\
\text{if } p_j^M > p^S
\end{array} \right\}
\end{aligned}$$

Since p^S is constant for all θ_j, instances may occur when $p_j^M \leq p^S$ (i.e. $\theta_j \leq w_S + \phi$). In this case, the Northern monopolist knows it can always undercut the price of any potential Southern imitator and secure the entire Southern market. Thus it does not fear being imitated and will always choose to export to gain access to a larger market. This translates mathematically into the piece-wise nature of the π^X function above.

$$\begin{aligned}
\Pi_j^N &= \max\left\{\pi^D, \pi^X\right\} \\
\Pi_N &= \int_1^{J(t)} \Pi_j^N dj
\end{aligned}$$

Let us define $\Delta \equiv \pi^X - \pi^D$ as the export premium to a Northern firm from exporting compared to selling only to its domestic market

$$\Delta = \left\{ \begin{array}{c} \Delta_1 \equiv \left(p_j^M - w_N\right) q_j^M L_S \\ \text{if } p_j^M \leq p^S \\ \Delta_2 \equiv \left[\left(p_j^M - w_N\right) q_j^M \left(\frac{L_S}{\omega L_N + L_S} - \rho\right) + \rho \cdot \max\left\{p^S - w_N, 0\right\} q_j^C\right] (\omega L_N + L_S) \\ \text{if } p_j^M > p^S \end{array} \right\}$$

$$= \left\{ \begin{array}{ll} (\theta_j - 1)\, \theta_j^{\frac{\theta_j}{1-\theta_j}} L_S & \text{if } \theta_j \leq w_S + \phi \\ \left[\begin{array}{c} (\theta_j - 1)\, \theta_j^{\frac{\theta_j}{1-\theta_j}} \left[\frac{L_S}{\omega L_N + L_S} - \rho\right] \\ +\rho \cdot \max\left\{w_S + \phi - 1, 0\right\} (w_S + \phi)^{\frac{\theta_j}{1-\theta_j}} \end{array} \right] (\omega L_N + L_S) & \text{if } \theta_j > w_S + \phi \end{array} \right\}$$

Since $p_j^C = p^S = w_S + \phi$ and $w_S < w_N = 1$, it is possible that $p^S < w_N$, causing $\max\{w_S + \phi - 1, 0\} = 0$. This would cause the export premium to be entirely governed by $(\theta_j - 1)\, \theta_j^{\frac{\theta_j}{1-\theta_j}} \left[\frac{L_S}{\omega L_N + L_S} - \rho\right]$ for all $\theta_j > w_S + \phi$ (i.e. $p_j^M > p^S$). Thus I make the following claim

Claim 4 *If $p^S < w_N$, then whenever $\frac{L_S}{\omega L_N + L_S} \geq \rho$, all goods will be exported by North and whenever $\frac{L_S}{\omega L_N + L_S} < \rho$, only products corresponding to $\theta_j \leq w_S + \phi$ will be exported.*

Proof. If $p^S < w_N$, then $\pi_j^C = 0$ for all goods with $\theta_j > w_S + \phi$, and thus the sign of the export premium is completely governed by the first term $(\theta_j - 1)\, \theta_j^{\frac{\theta_j}{1-\theta_j}} \left[\frac{L_S}{\omega L_N + L_S} - \rho\right]$, i.e. by whether $\frac{L_S}{\omega L_N + L_S} \gtreqless \rho$. When $\frac{L_S}{\omega L_N + L_S} \geq \rho$ then the export premium is positive for all goods in the domain. When $\frac{L_S}{\omega L_N + L_S} < \rho$ then the export premium is only positive for goods with monopoly prices below the Southern marginal cost of production $\theta_j \leq w_S + \phi$. ■

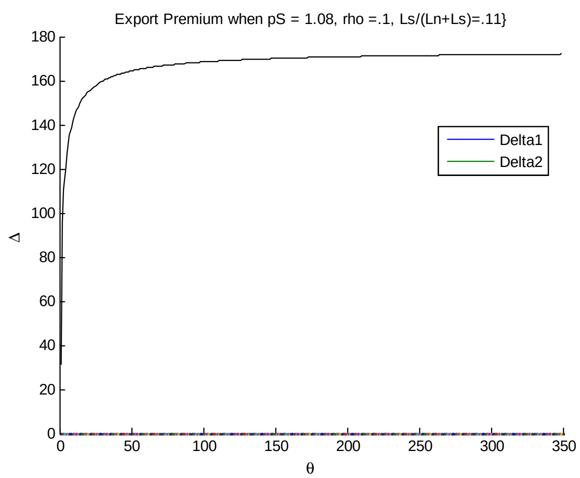
Henceforth, I restrict attention to the case when $p_j^C = p^S > w_N$, both because it is the more interesting case and because the alternative case only provides an all-or-nothing criterion for product exports as we see from Claim 5. Thus the export premium can be simplied to

$$\Delta = \left\{ \begin{array}{c} \Delta_1 \equiv (\theta_j - 1)\, \theta_j^{\frac{\theta_j}{1-\theta_j}} L_S \\ \text{if } \theta_j \leq w_S + \phi \\ \Delta_2 \equiv \left[(\theta_j - 1)\, \theta_j^{\frac{\theta_j}{1-\theta_j}} \left[\frac{L_S}{\omega L_N + L_S} - \rho\right] + \rho\, (w_S + \phi - 1)\, (w_S + \phi)^{\frac{\theta_j}{1-\theta_j}} \right] (L_N + L_S) \\ \text{if } \theta_j > w_S + \phi \end{array} \right\}$$

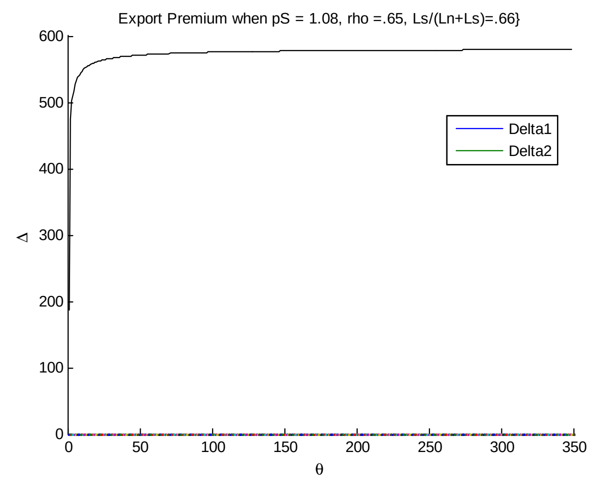
Proposition 5 *If South's share of world population is larger than the probability of imitation, all differentiated varieties in existence J will be exported for any level of IPR protection*

Proof. Only if Δ is positive will a given Northern firm choose to export its product to the South and risk its technology being pirated. The expression above is positive for all values of $\theta_j > 1$ as long as $\frac{L_S}{\omega L_N + L_S} > \rho$. So when South's share of world population is sufficiently large, that is, larger than the probability of Southern firms imitating its technology, all Northern firms have an incentive to export their varieties and all varieties J will be exported. This is entirely independent of the level of IPR protection as measured by ϕ. ■

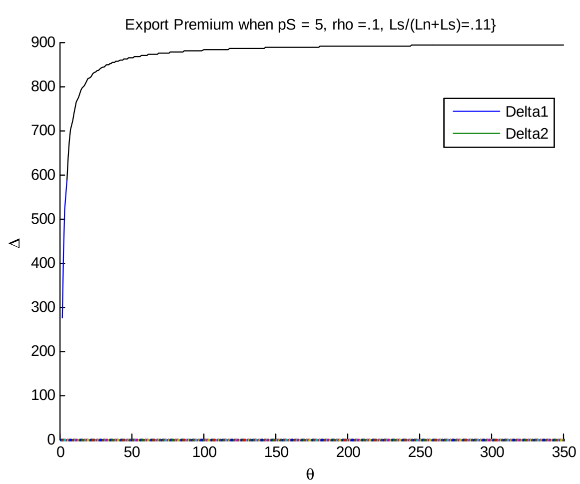
Figure 1.2. Graphs of Δ when $\frac{L_S}{\omega L_N + L_S} > \rho$



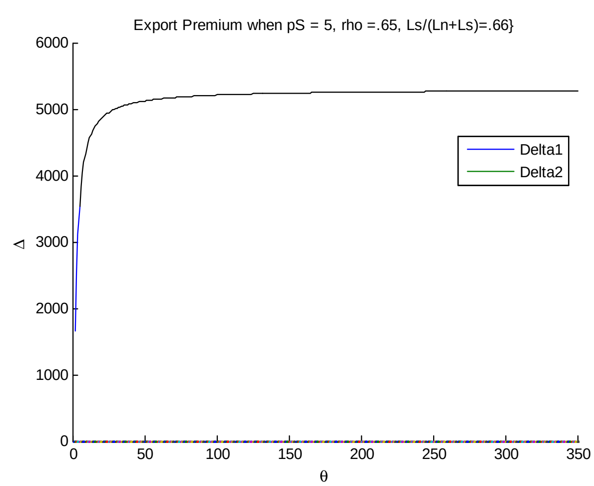
(a) Δ when $p^S = 1.08$ and $\frac{L_S}{\omega L_N + L_S}$ and ρ both low



(b) Δ when $p^S = 1.08$ and $\frac{L_S}{\omega L_N + L_S}$ and ρ both high



(c) Δ when $p^S = 5$ and $\frac{L_S}{\omega L_N + L_S}$ and ρ both low



(d) Δ when $p^S = 5$ and $\frac{L_S}{\omega L_N + L_S}$ and ρ both high

The graphs in Figure 1.2 highlight that all goods are traded whenever $\frac{L_S}{\omega L_N + L_S} > \rho$.

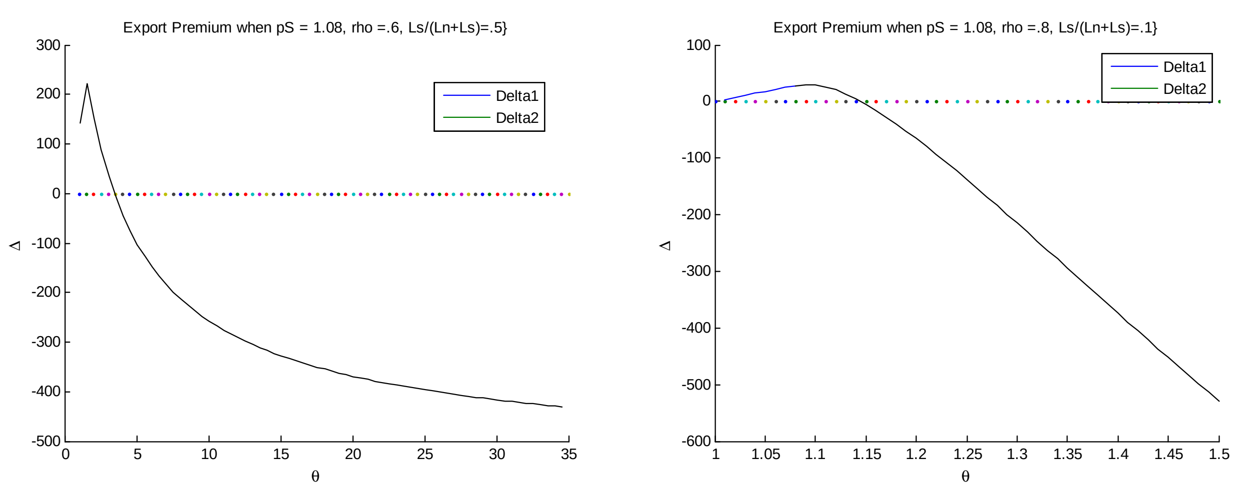
Note the result that this is independent of IPR protection goes away if we assume that IPR protection also impacts ρ. However, when South's share of world population is sufficiently low or when the probability of imitation is sufficiently high, we obtain the following result.

Proposition 6 *When the population share of South is lower than the probability of piracy, $\frac{L_S}{\omega L_N + L_S} < \rho$, if there exists any Northern firm choosing to export (i.e. $w_S + \phi > w_N$), then for any ρ and $\frac{L_S}{\omega L_N + L_S}$ where the relative marginal gain under piracy is lower than the piracy probability, $(w_S + \phi)\frac{L_S}{\omega L_N + L_S} < \rho$, there exists a unique cutoff $\hat{\theta}_j$ such that for all $\theta_j \in (1, \hat{\theta}_j]$ Northern firms corresponding to those varieties will choose to export their product to South, while for all $\theta_j \in (\hat{\theta}_j, \infty)$ Northern firms will not export their product to South. Thus, there exists a convex subset, J^S, of the total product set, J, which is exported by North to South.*

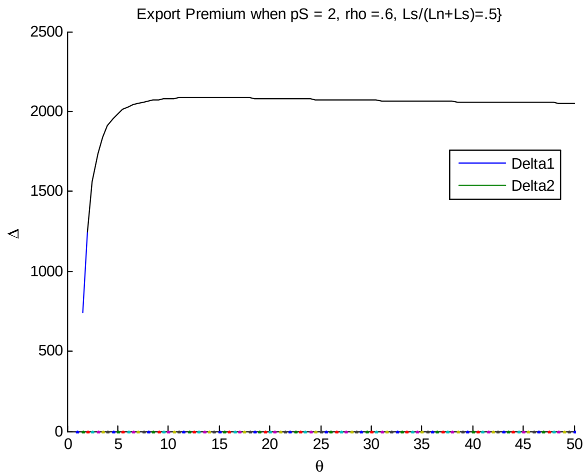
Proof. In Appendix. ■

In Figure 1.3 below, panels (c), (e), (g) and (h) display graphs of the export premium when the necessary conditions of Proposition 2 are not satisfied; thus they are examples of when North exports all products in existence, J, as is seen by the positive export premium over the entire range of θ_j. The other graphs in Figure 3 highlight various cutoff values, $\hat{\theta}_j$, under different parameter specifications.

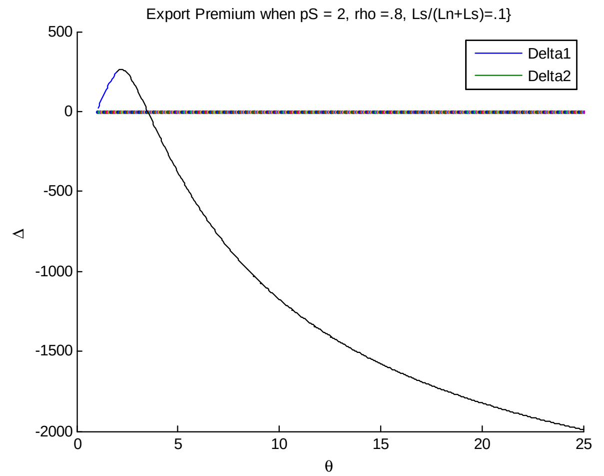
Figure 1.3. Graphs of Δ when $\frac{L_S}{\omega L_N + L_S} < \rho$ and $w_S + \phi > w_N$



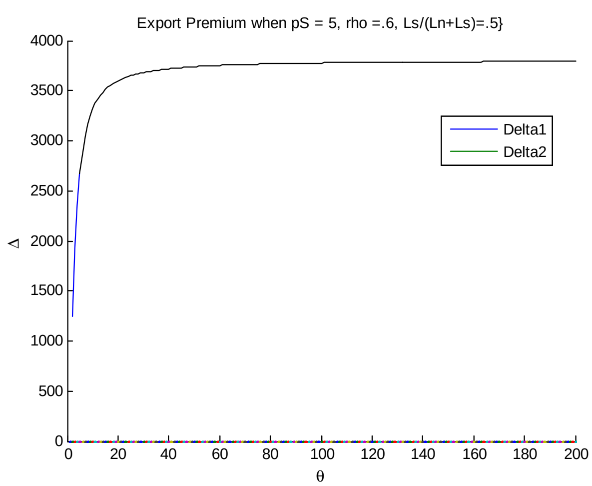
(a) Δ when $p^S = 1.08$ and $\rho - \frac{L_S}{\omega L_N + L_S}$ is low (b) Δ when $p^S = 1.08$ and $\rho - \frac{L_S}{\omega L_N + L_S}$ is high



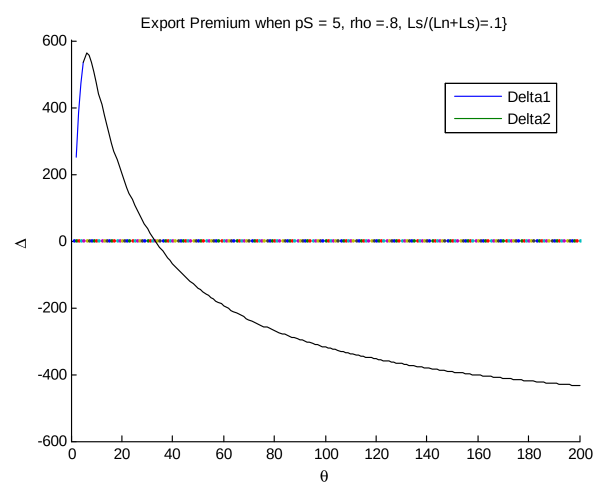
(c) Δ when $p^S = 2$ and $\rho - \frac{L_S}{\omega L_N + L_S}$ is low



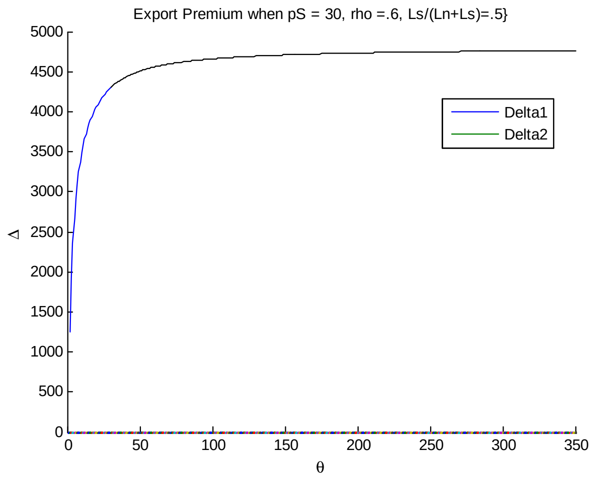
(d) Δ when $p^S = 2$ and $\rho - \frac{L_S}{\omega L_N + L_S}$ is high



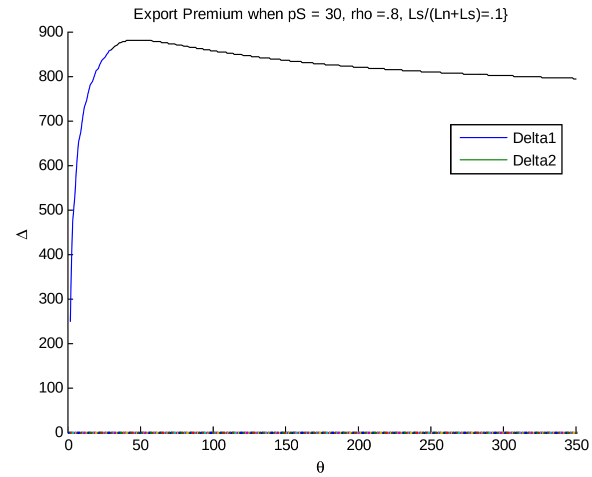
(e) Δ when $p^S = 5$ and $\rho - \frac{L_S}{L_N + L_S}$ is low



(f) Δ when $p^S = 5$ and $\rho - \frac{L_S}{L_N + L_S}$ is high



(g) Δ when $p^S = 30$ and $\rho - \frac{L_S}{\omega L_N + L_S}$ is low



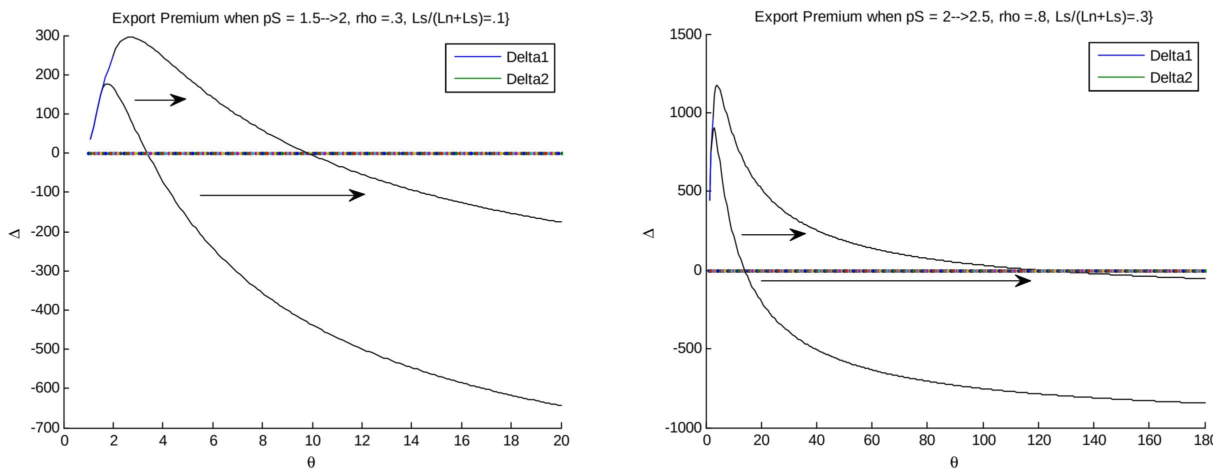
(h) Δ when $p^S = 30$ and $\rho - \frac{L_S}{\omega L_N + L_S}$ is high

Proposition 7 *A higher level of IPR protection, ϕ, in the South, is characterized by both (1) a greater absolute number of available goods, $J^S(t)$ (characterized by $\Delta > 0$) and (2) the availabiity of more inelastically demanded (higher θ_j) goods*

Proof.

$$\frac{\partial \Delta}{\partial \phi} = \rho \left(\omega L_N + L_S\right) \left[\left(w_S + \phi\right)^{\frac{\theta_j}{1-\theta_j}} + \left(w_S + \phi - 1\right) \left(w_S + \phi\right)^{\frac{2\theta_j - 1}{1-\theta_j}} \right] > 0$$

As the critical $\hat{\theta}_j$ is unique, increasing ϕ will only shift Δ to the right, leading to a higher critical $\hat{\theta}_j$. Thus all lower θ_j goods exported previously will still be exported, but the set will simply expand to include higher θ_j products. ■



(a) Δ when ϕ increases such that $p^S = 1.5 \rightarrow 2$ (b) Δ when ϕ increases such that $p^S = 2 \rightarrow 2.5$

Figure 1.4. The effect on Δ of an increase in ϕ

Proposition 8 *A higher piracy rate ρ in the South, is characterized by both (1) a lower absolute number of available goods and (2) the loss in availability of more inelastically demanded (higher θ_j) goods*

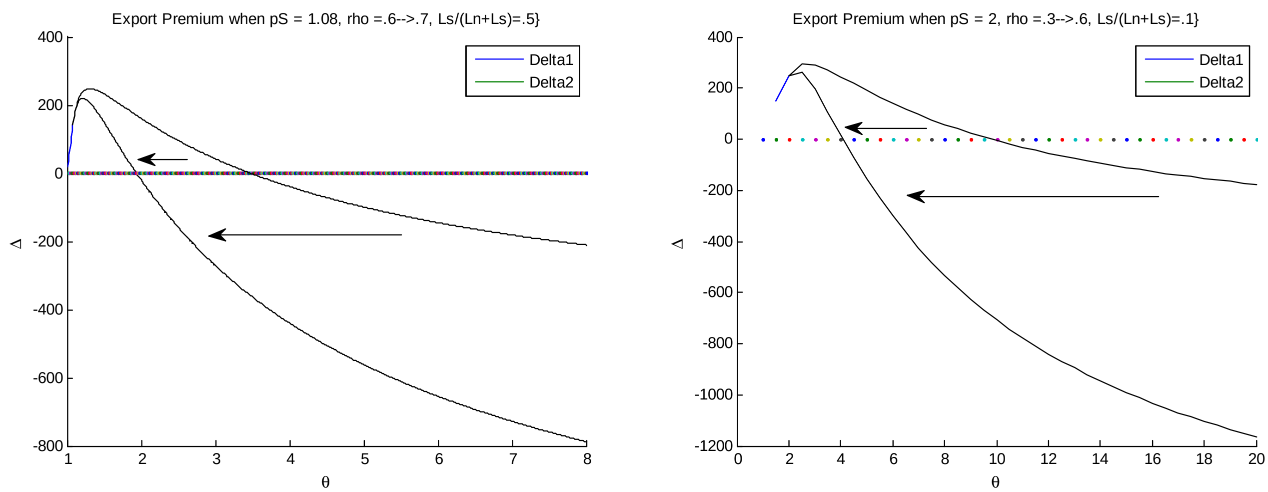
Proof. Still assuming that $w_S + \phi \leq \min\{\theta_j\} \Rightarrow (\theta_j - 1)\,\theta_j^{\frac{\theta_j}{1-\theta_j}} > \left(\frac{w_S}{\gamma_1^S} + \phi - 1\right)(w_S + \phi)^{\frac{\theta_j}{1-\theta_j}}$ and thus

$$\Delta = \left\{(\theta_j - 1)\,\theta_j^{\frac{\theta_j}{1-\theta_j}}\left[\frac{L_S}{\omega L_N + L_S} - \rho\right] + \rho\cdot(w_S + \phi - 1)(w_S + \phi)^{\frac{\theta_j}{1-\theta_j}}\right\}(\omega L_N + L_S)$$

$$\frac{\partial \Delta}{\partial \rho} = (\omega L_N + L_S)\left[(w_S + \phi - 1)(w_S + \phi)^{\frac{\theta_j}{1-\theta_j}} - (\theta_j - 1)\,\theta_j^{\frac{\theta_j}{1-\theta_j}}\right] < 0$$

■

Propositions 3 and 4, plus the fact that a higher θ_j corresponds to more inelastic demand, together allow us to conclude that, within the framework of differentiated varieties, Southern consumers sustain welfare losses due to piracy and low IPR protection both in terms of the absolute number of goods as well as the type of good, based on its demand elasticity.



(a) Δ when $p^S = 1.08$ and $\rho = .6 \rightarrow .7$ (b) Δ when $p^S = 2$ and $\rho = .3 \rightarrow .6$

Figure 1.5. The effect on Δ of an increase in ρ

1.4.3 The South

Restricting attention again to the case in which the homogeneous good is produced in South in equilibrium, we know that $w_S = \gamma_0^S$ and $p_0 = p_S = w_S + \phi = \gamma_0^S + \phi$ where $\gamma_0^S < 1$ is the productivity parameter for South's production of the homogeneous good. Thus, for, n_S, the set of goods exported by North and imitated by South, $p_S = w_S + \phi$, while for the set of goods exported by North but not imitated by South, n_N, the monopoly price still prevails $p^M = \theta_j$. Recall that together these two sets comprise the total set of goods available in the South, that is, exported by North: $n_N + n_S = J^S \equiv \{j : \Delta \geq 0\}$. Thus the cutoff $\hat{\theta}_j = \left\{\theta_j : j = \max\left\{J^S\right\}\right\}$.

Then the ideal price index in the South can be represented by the solution to the expenditure minimization problem

$$\min p_0 q_0 + \int_1^{J^S} p_j q_j dj = p_0 q_0 + \int_{j \in n_N} p_j q_j dj + \int_{j \in n_S} p_j q_j dj$$

$$\text{s.t. } u = q_0 + \int_1^{J^S} \theta_j q_j^{\frac{1}{\theta_j}} dj = 1$$

with the associated first order condition

$$\begin{aligned} q_j &= \left(\frac{p_j}{p_0}\right)^{\frac{\theta_j}{1-\theta_j}} \\ &\Rightarrow\ q_0 = 1 - \int_1^{J^S} \theta_j \left(\frac{p_j}{p_0}\right)^{\frac{1}{1-\theta_j}} dj \end{aligned}$$

Thus the price index in South is given by

$$\begin{aligned} \mathbf{P}^S &= p_0 - \int_1^{J^S} \theta_j p_0^{\frac{\theta_j}{\theta_j-1}} p_j^{\frac{1}{1-\theta_j}} dj + \textstyle\int_1^{J^S} p_0^{\frac{\theta_j}{\theta_j-1}} p_j^{\frac{1}{1-\theta_j}} dj \\ &= p_0 - \int_{j\in n_N} \theta_j p_0^{\frac{\theta_j}{\theta_j-1}} p_j^{\frac{1}{1-\theta_j}} dj - \int_{j\in n_S} \theta_j p_0^{\frac{\theta_j}{\theta_j-1}} p_j^{\frac{1}{1-\theta_j}} dj + \int_{j\in n_N} p_0^{\frac{\theta_j}{\theta_j-1}} p_j^{\frac{1}{1-\theta_j}} dj \\ &\quad + \int_{j\in n_S} p_0^{\frac{\theta_j}{\theta_j-1}} p_j^{\frac{1}{1-\theta_j}} dj \end{aligned}$$

where the second equality breaks the price index into components depending on whether the good was pirated ($j \in n_S$) or not ($j \in n_N$). Note that for unpirated products $j \in n_N$, monopoly prices $p_j = \theta_j$ remain in place, while for pirated products $j \in n_S$, Southern competitive prices prevail, $p_j^S = \gamma_0^S + \phi$. Plugging back in these differentiated goods prices, as well as the Southern competitive price for the homogeneous good $p_0 = p_j^S = \gamma_0^S + \phi$ (full derivation in Mathematical Appendix) we have

$$\begin{aligned} \mathbf{P}^S &= \left(1 + n_S - \int_{j\in n_S} \theta_j dj\right)\left(\gamma_0^S + \phi\right) - \int_{j\in n_N} \theta_j \left(\gamma_0^S + \phi\right)_j^{\frac{\theta_j}{\theta_j-1}} \theta_j^{\frac{1}{1-\theta_j}} dj \\ &\quad + \int_{j\in n_N} \left(\gamma_0^S + \phi\right)^{\frac{\theta_j}{\theta_j-1}} \theta_j^{\frac{1}{1-\theta_j}} dj \\ &= \left(1 + n_S - \int_{j\in n_S} \theta_j dj\right)\left(\gamma_0^S + \phi\right) + \int_{j\in n_N} (1-\theta_j)\left(\gamma_0^S + \phi\right)_j^{\frac{\theta_j}{\theta_j-1}} \theta_j^{\frac{1}{1-\theta_j}} dj \end{aligned}$$

1.4.4 Welfare Analysis

The South

Together, Claim 2 and Theorem 2 imply that, when IPR protection is lower, Southern consumers are strictly worse off in terms of both the absolute availability of varieties as well as the availability of varieties they demand more inelastically. This result is contrary to the previous literature which finds that the South never has an incentive to increase its IPR protection in the short-run, without invoking dynamic innovation considerations. However, Southern consumers enjoy a lower price for all goods that remain exported by North and are imitated by Southern firms. Thus the presence of piracy is beneficial to Southern consumers along the price margin; some of what was previously producer surplus is then transfered to consumers. The welfare effect of an increase in IPR on the South is essentially a tradeoff of consumer welfare between the intensive margin of prices of available goods and the extensive margin of the availability of product varieties.

Since all imitated products transform into perfectly competitive industries, Southern welfare can be simply defined as real wages and expressed as

$$\mathbf{W}^S \equiv \frac{w_S}{\mathbf{P}^S} = \frac{\gamma_0^S}{\left(1 + n_S - \int_{j \in n_S} \theta_j dj\right)\left(\gamma_0^S + \phi\right) + \int_{j \in n_N} \left(1 - \theta_j\right)\left(\gamma_0^S + \phi\right)_j^{\frac{\theta_j}{\theta_j - 1}} \theta_j^{\frac{1}{1-\theta_j}} dj}$$

Claim 9 *An increase in IPR protection, i.e. an increase in ϕ, has an ambiguous overall effect on Southern welfare.*

Proof. Given that the probability of piracy, ρ, is exogenous and constant for all values of θ_j, we know that the strength of IPR protection, ϕ, only affects n_S and n_N directly through its effect on the set of goods exported to South J^S. As established by Propositions 3 and 4, as IPR protection increases, the set J^S expands and thus n_S and n_N expand also.

$$\begin{aligned}\frac{\partial \mathbf{P}^S}{\partial \phi} &= \left(1 + n_S - \int_{j \in n_S} \theta_j dj\right) - \left(\gamma_0^S + \phi\right)\left(n_S'(\phi) + \int_{j \in n_S'(\phi)} \theta_j dj\right) \\ &\quad + \frac{\partial}{\partial \phi} \int_{j \in n_N} \left(\gamma_0^S + \phi\right)^{\frac{\theta_j}{\theta_j - 1}} \left(1 - \theta_j\right) \theta_j^{\frac{1}{1-\theta_j}} dj\end{aligned}$$

The second term $-\left(\gamma_0^S + \phi\right)\left(n_S'(\phi) + \int_{j \in n_S'(\phi)} \theta_j dj\right) < 0$, while the third term, though not directly calculable since we cannot precisely define the set n_N, is also negative, by the Leibniz rule. We can see this is true because increasing ϕ causes both n_N and $\left(\gamma_0^S + \phi\right)_j^{\frac{\theta_j}{\theta_j - 1}}$ to grow, while $\left(1 - \theta_j\right) \theta_j^{\frac{1}{1-\theta_j}} < 0$ for the entire domain. These both point to the price index decreasing with greater IPR protection and thus overall welfare increasing with greather protection. However, the first term above, $1 + n_S - \int_{j \in n_S} \theta_j dj$, is of ambiguous sign. Thus the overall effect on welfare of an increase in IPR protection is ambiguous and depends on the particular case under examination which would define the sets n_S and n_N. ■

To see this another way, isolating both sides of the inequality to only include positive terms, we get that Southern welfare is increasing in IPR strength, i.e. $\frac{\partial \mathbf{W}^S}{\partial \phi} > 0$ or $\frac{\partial \mathbf{P}^S}{\partial \phi} < 0$, whenever

$$\begin{aligned}
1+n_S-\left(\gamma_0^S+\phi\right)n_S'(\phi) &< \left(\gamma_0^S+\phi\right)\int_{j\in n_S'(\phi)}\theta_j dj+\int_{j\in n_S}\theta_j dj \\
&\quad -\frac{\partial}{\partial\phi}\int_{j\in n_N}\left(\gamma_0^S+\phi\right)^{\frac{\theta_j}{\theta_j-1}}\left(1-\theta_j\right)\theta_j^{\frac{1}{1-\theta_j}}dj \\
1+n_S-p_j^S n_S'(\phi) &< \left(p_j^S\right)\int_{j\in n_S'(\phi)}p_j^M dj+\int_{j\in n_S}p_j^M dj \\
&\quad -\frac{\partial}{\partial\phi}\int_{j\in n_N}\left(p_j^S\right)^{\frac{\theta_j}{\theta_j-1}}\left(1-\theta_j\right)\theta_j^{\frac{1}{1-\theta_j}}dj
\end{aligned}$$

The opposite is true whenever the inequality above is reversed. The fact that Southern welfare is potentially non-monotone in IPR protection points to the possible existence of an optimal level of protection with respect to the South.

The North

This model also allows potential welfare gains for North under lowered IPRs. Because I assume that products, once imitated by South, can be partially re-exported back to North at a lower price, Northern consumers can experience welfare gains from higher real wages, even as Northern firms experience profit margin reductions. In addition, Northern firms also stand to gain a share of the expected total IP reparations, $\rho J\cdot\phi$, from instances when South has detected and fined pirates for imitation of their products. Imposing transport costs or other frictional trade barriers to the re-exportation of imitated products by South does not affect the existence of this additional mechanism, only the magnitude for particular cases.

Let $J^N=\{j:\Delta<0\}$ be the set of goods not exported by North. The general form of the previous closed economy price index in North is reproduced below

$$\mathbf{P}^N=p_0-\int_1^J p_0^{\frac{\theta_j}{\theta_j-1}}\theta_j p_j^{\frac{1}{1-\theta_j}}dj+\int_1^J p_0^{\frac{\theta_j}{\theta_j-1}}p_j^{\frac{1}{1-\theta_j}}dj$$

Plugging in the monopoly price $p_j^N=\theta_j$ for goods that are not exported and goods that are exported and not imitated $(J^N\cup n_N)$, in addition to the Southern competitive price $p_j^S=\gamma_0^S+\phi$ for goods that are exported and imitated, we have

$$\begin{aligned}
\mathbf{P}^N &= \gamma_0^S+\phi-\int_{j\in J^N\cup n_N}\theta_j p_j^{\frac{1}{1-\theta_j}}dj-\int_{j\in n_S}\theta_j p_j^{\frac{1}{1-\theta_j}}dj+\int_{j\in J^N\cup n_N}p_j^{\frac{1}{1-\theta_j}}dj+\int_{j\in n_S}p_j^{\frac{1}{1-\theta_j}}dj \\
&= \gamma_0^S+\phi+\int_{j\in J^N\cup n_N}\theta_j^{\frac{1}{1-\theta_j}}-\theta_j^{\frac{2-\theta_j}{1-\theta_j}}dj+\int_{j\in n_S}\left(1-\theta_j\right)\left(\gamma_0^S+\phi\right)^{\frac{1}{1-\theta_j}}dj
\end{aligned}$$

Northern per-worker profits, under trade, (more detailed derivation in Mathematical Appendix) are now

$$
\begin{aligned}
\frac{\Pi_N}{L_N} &= \int_{j\in J^N}\pi_j^M dj + \int_{j\in n_N}\left(1+\frac{L_S}{L_N}\right)\pi_j^M dj + \int_{j\in n_S}\left(1+\frac{L_S}{L_N}\right)\pi_j^C dj \\
&= \int_{j\in J^N(t)}\left[\theta_j^{\frac{1}{1-\theta_j}} - \theta_j^{\frac{\theta_j}{1-\theta_j}}\right]dj + \int_{j\in n_N}\left(1+\frac{L_S}{L_N}\right)\left[\theta_j^{\frac{1}{1-\theta_j}} - \theta_j^{\frac{\theta_j}{1-\theta_j}}\right]dj \\
&\quad + \int_{j\in n_S}\left(1+\frac{L_S}{L_N}\right)\left(\gamma_0^S+\phi-1\right)\left(\gamma_0^S+\phi\right)^{\frac{\theta_j}{1-\theta_j}}dj
\end{aligned}
$$

Thus, combining and simplifying the above, welfare in North in an open economy with piracy can be expressed as

$$
\begin{aligned}
\mathbf{W}^N &\equiv \frac{w_N}{\mathbf{P}^N} + \frac{\frac{\Pi_N}{L_N}}{\mathbf{P}^N} + \frac{\rho J\phi}{\mathbf{P}^N} \\
&= \frac{1+\int_{j\in J^N}\pi_j^M dj + \int_{j\in n_N}\left(1+\frac{L_S}{L_N}\right)\pi_j^M dj + \int_{j\in n_S}\left(1+\frac{L_S}{L_N}\right)\pi_j^C dj + \rho J\phi}{\left(\gamma_0^S+\phi\right) + \int_{j\in J^N\cup n_N}\theta_j^{\frac{1}{1-\theta_j}} - \theta_j^{\frac{2-\theta_j}{1-\theta_j}}dj + \int_{j\in n_S}\left(1-\theta_j\right)\left(\gamma_0^S+\phi\right)^{\frac{1}{1-\theta_j}}dj}
\end{aligned}
$$

The welfare effect of an increase in IPR protection in North is a tradeoff between static consumer and producer welfare and hinges on the assumption that firm profits can be impacted by piracy through the infiltration of pirated products on a firm's existing market base. Increasing IPR protection simultaneously (weakly) raises consumer prices in North while increasing Northern firm profits.

Claim 10 *An increase in IPR protection, i.e. an increase in ϕ, has an ambiguous overall effect on Northern welfare.*

Proof. The numerator in the above, which I denote X, is clearly positive. Its derivative with respect to the final term in X, the expected value of IP violations fines, is $\rho J > 0$. The derivative of the first four terms of X with respect to ϕ is of uncertain sign; we know that π_j^M does not depend on ϕ and π_j^C, n_N and n_S are all increasing in ϕ, thus the third and fourth terms of X are increasing in ϕ, however since J^N is decreasing in ϕ, so is the second term in the numerator, thus the overall sign of X is unknown.

The denominator in the above, denoted Y, is negative since both $\theta_j^{\frac{1}{1-\theta_j}} - \theta_j^{\frac{2-\theta_j}{1-\theta_j}}$ and $\left(1-\theta_j\right)\left(\gamma_0^S+\phi\right)^{\frac{1}{1-\theta_j}}$ are negative along the domain. Its derivative with respect to ϕ is again uncertain since the first term of Y is increasing with respect to ϕ, while the third term decreases with respect to the parameter. With regard to the limits of integration of the second term, since J^N decreases relatively more than n_N increases as ϕ rises (i.e. the number of goods not exported falls more than the number of unimitated products grows, since not all exported goods are imitated), $J^N \cup n_N$ decreases in number and the second term becomes less negative. Since increasing ϕ causes the set to expand, the third term becomes more negative. The overall effect is ambiguous. Thus we have $\frac{\partial \mathbf{W}^N}{\partial \phi} = \frac{Y \partial X - X \partial Y}{Y^2} \gtreqless 0$. The effect of a strengthening of Southern IPRs on Northern welfare will have a positive effect if $Y \partial X - X \partial Y > 0$, and vice versa. The derivative $\partial X > 0$, so this can only occur if ∂Y is sufficiently negative. ■

1.5 Model Extensions

1.5.1 Endogenous Imitation

Suppose the imitation probability ρ was endogenous. Given that higher j (and thus higher θ_j) products are more profitable for Northern firms, it makes sense that Southern imitators would prefer to imitate the highest θ_j goods available first, to capture instanteous, albeit extremely brief, higher profits before other firms enter, driving the market to perfect competition.

Let $\rho = \rho_j$ where $\frac{\partial \rho_j}{\partial j} = \frac{\partial \rho_j}{\partial \theta_j} > 0$. Intuitively, this should only help my result by making more inelastic goods even riskier for N to export. I again define the export premium

$$\Delta = \left\{ \begin{array}{cc} (\theta_j - 1)\, \theta_j^{\frac{\theta_j}{1-\theta_j}} L_S & \text{if } \theta_j \leq w_S + \phi \\ \left[\begin{array}{c} (\theta_j - 1)\, \theta_j^{\frac{\theta_j}{1-\theta_j}} \left[\frac{L_S}{\omega L_N + L_S} - \rho_j \right] \\ + \rho_j \left(w_S + \phi - 1 \right) \left(w_S + \phi \right)^{\frac{\theta_j}{1-\theta_j}} \end{array} \right] (L_N + L_S) & \text{if } \theta_j > w_S + \phi \end{array} \right\}$$

Claim 11 *If $p^C < w_N$ then if $p_j^M > p^S$, only goods for which $\frac{L_S}{\omega L_N + L_S} \geq \rho_j$ are exported*

Proof. Obvious. ■

Proposition 12 *If South's share of world population is larger than the probability of imitation, $\frac{L_S}{\omega L_N + L_S} > \rho_j$, then firm j will export its product regardless of the level of IPR protection*

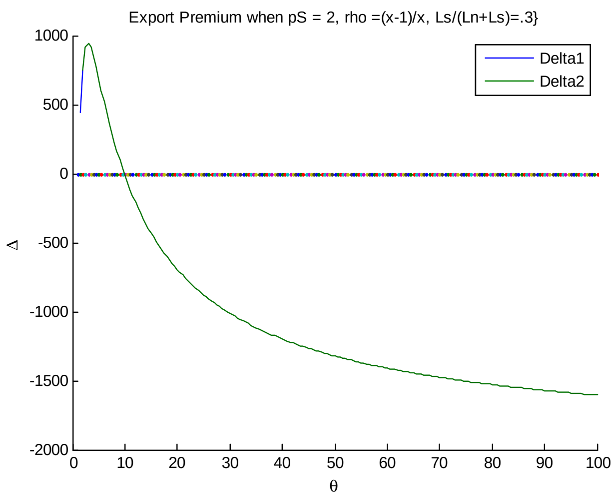
Proof. Omitted; analogous to proof of Proposition 1 ■

Proposition 13 *For firms facing a probability of piracy higher than the population share of South, $\frac{L_S}{\omega L_N + L_S} < \rho_j$, if the Southern competitive price of goods is higher than the Northern wage (i.e. $w_S + \phi > w_N$), then for any w_S, ϕ, $\frac{L_S}{\omega L_N + L_S}$ and strictly increasing piracy probability*

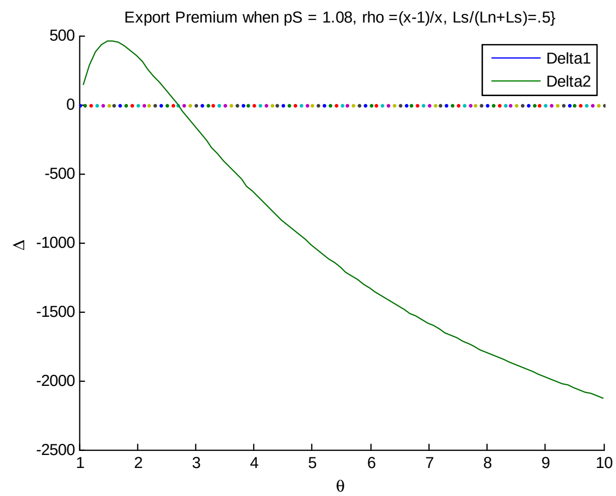
ρ_j, where the population share of South is less than the marginal cost to benefit ratio of pirated goods, $\frac{L_S}{\omega L_N + L_S} < \frac{1}{w_S + \phi}$, there exists a unique cutoff $\hat{\theta}_j$ such that for all $\theta_j \in (1, \hat{\theta}_j]$ Northern firms corresponding to those varieties will choose to export their product to South, while for all $\theta_j \in (\hat{\theta}_j, \infty)$ Northern firms will not export their product to South. Thus, there exists a convex (strict) subset, $J^S(t)$, of the total product set, $J(t)$, which is exported by North to South.

Proof. Omitted; analogous to proof of Proposition 2 ■

Example **(1)** *Suppose $\rho_j = \frac{\theta_j - 1}{\theta_j}$, and thus $\frac{\partial \rho_j}{\partial \theta_j} > 0$*



(a) Δ when $p^S = 2$ and $\frac{L_S}{L_N + L_S}$ and ρ both low



(b) Δ when $p^S = 1.08$ and $\frac{L_S}{L_N + L_S}$ and ρ both high

1.6 Trade and Intellectual Property in the Data

In this section, I explore whether the results of the theoretical model appear in the data. I test whether there is an asymmetric impact on trade of differing product varieties, as distinguished by their respective import elasticities[3], between strong relative to weak IPR destination markets. I conduct both cross-section and panel estimations to explore whether trade product composition varies as a result of differing IPR regimes, and find that the results predicted in the theoretical model are consistent with the data.

Throughout the analysis, I conduct each test for both the full sample and the 95th percentile of the sample in terms of product demand elasticity (keeping 95% of the goods most

[3]As estimated in Broda, Weinstein and Greenfield (2006) and further discussed later.

inelastically demanded and therefore more likely to be differentiated goods). Goods corresponding to the highest 5% of demand elasticities represent the homogeneous good and low-profit differentiated goods in the theory, which correspond to the highest elasticity products and are not theoretically expected to be affected by IPR levels. The results are not sensitive to the precise choice of the subsample percentile, within some range, but logically require that not too many of the most elastic goods are removed as it is difficult to define, elasticity-wise, the exact cutoff for which a good becomes homogeneous as opposed to differentiated[4].

1.6.1 Data

I use annual bilateral UN Comtrade product-level import data for 2005 in the cross-sectional analysis and for the period 1990-2002 in the panel analysis. The trade data contain information on import value and quantity for each of 250 SITC Rev. 2 4-digit products for 73 importing countries trading with 73 origin countries. Utilizing a cross-walk between SITC 4-digit Rev. 2 and HS 6-digit 1998/1992 codes, I match each product-level import to its corresponding Broda-Weinstein country-specific estimated demand elasticity at the HS 3-digit level, resulting in 102 product categories.

Table 1.1 gives the overall descriptive statistics of the full sample as well as subsamples. Individual product demand elasticities (σ's) differ across countries, thus several measures are employed with the corresponding statistics shown in the table. The average standard deviation of a given product's σ across countries is 17.15. Details of the different elasticity measures used will be discussed in the next section. A detailed description of product categories at the HS 3-digit level is available in the Appendix.

For the cross-sectional estimation, I also use Park (2008) country-level IPR strength estimates. For the panel, I use the IP reforms documented in Branstetter et al. (2006) and defer to their detailed description of the identification of those reforms. Of the 16 national IP reforms they document, I focus on six (Argentina, Brazil, China, Colombia, Turkey and Venezuela), for which there exist both sufficient Commtrade data and Broda-Weinstein country-product elasticities.

[4] I also conduct a test using the Rauch (1999) classification of good homogeneity as a robustness check, with all results qualitatively the same.

1.6.2 Cross-Sectional Evidence

Unilateral Import Data

Using country-product level import data, with importer and product fixed effects, I estimate .

$$\ln(Imports_{ij}) = \beta_0 + \beta_1\sigma_{ij} + \beta_2 IPIndex_i + \beta_3\sigma_{ij} \times IPIndex_i + \mu_i + \mu_j + \varepsilon_{ij} \quad (1.1)$$

where $Imports_{ij}$ are the imports of product j to i, σ_{ij} is country i's demand elasticity for product j, $IPIndex_i$ is a measure of country i's IP protection strength, μ_i is a set of importer fixed-effects and μ_j are product fixed-effects. $IPIndex_i$ is an IPR strength indicator developed in Park (2008) ranging continuously from 1-5, with 5 representing the strongest level. In the estimation, I renormalize the elasticities in terms of standard deviations and the Park IP Index on a 0-1 scale in order for the coefficients to have a more intuitive interpretation. The results are presented in Table 1.2.

The statistic of interest is the coefficient on $\sigma_{ij} \times IPIndex_i$. These coefficients reflect the relatively lower chance of good j being imported into country i compared to a good which is more inelastically demanded, when the IP Index of country i is higher. The results imply that, relative to countries with the lowest IPR strength (a Park index of 1), countries with the strongest IPRs (an index of 5) observe a .113% lower import value of elastically demanded goods for every one standard deviation increase in elasticity. This implies that, not only are goods of different demand elasticity impacted differently based on the degree of destination IP protection, but the relatively inelastically demanded goods are the ones enjoying greater importation under stronger IPRs.

Restricting the sample to exclude implausibly high estimated elasticities above the 95th percentile of elasticities, which may speak to a high degree of product homogeneity unlikely to be affected by IPRs, consistent with the theoretical model, I find that countries with the strongest IPRs observe a .447% lower import value of elastically demanded goods for every one standard deviation increase in elasticity relative to countries with the weakest IPRs. So again, higher IPR countries appear to import relatively inelastically demanded (from their standpoint) products more than lower IPR countries.

The coefficients on $\sigma(Importer)$ are all positive and largely significant, suggesting that trade of more elastic goods tends to be greater relative to more inelastically demanded goods when not accounting for destination IPRs. The coefficients also point to the logical result that destinations with higher IPRs receive more imports.

Bilateral Import Data

Full Sample Utilizing bilateral trade data and thus being able to further control for all bilateral gravity variables via fixed-effects, I estimate the following

$$\ln(Imports_{ixj}) = \beta_0 + \beta_1\sigma_{ij} + \beta_2 IPIndex_i + \beta_3\sigma_{ij} \times IPIndex_i + \mu_{ix} + \mu_j + \varepsilon_{ixj} \quad (1.2)$$

with the only difference from (1) being the presence of bilateral fixed-effects represented by μ_{ix}.

In my model, I had assumed symmetric consumer preferences in both trading partners. Given that preferences for each good actually dffer across countries, it is not immediately obvious which market's import demand elasticities should be used in the empirical analysis. For example, if the home market was sufficiently large in the model and re-exportation was substantial, a Northern firm might base its export decision more strongly on the profitability (and thus demand elasticity) of its product within the home market. Theoretically, because of symmetric cross-country product preferences, relative market sizes did not play a substantial role. However, given that cross-country preferences actually differ, it is conceivable that an exporting firm would weigh its home market's preferences more heavily in making its decision as its profits may derive mostly from the home market and thus their decision may hinge primarily on the fear of imitation due to price spillover effects into the home market.

For robustness to check on the sensitivity of results to the choice of which market's elasticity is used for a given product, I run the estimation with 3 specifications: $\sigma(Importer)$, $\sigma(Exporter)$ and $\sigma(Trade - weighted)$, each interacted with the IP index. Due to variance of product-level elasticity elements across countries, I construct $\sigma(Trade - weighted)$ as a trade-weighted elasticity measure, from the exporter's point of view. I do this by weighting the relative importance of each market, including the home market, in contributing to the exporter's total trade by using the following formula: $\sigma(Trade - weighted) = \frac{Import_x}{Import_x + Export_x}\sigma(Exporter_x) + \frac{Export_x}{Import_x + Export_x}\sum_{\forall i}\frac{Exports_{xi}}{Export_x}\sigma(Importer_i)$. The exporter's perspective is chosen in this constructed elasticity due to the fact that it is the exporter that determines the traded value based on its customers and their corresponding institutional environment.

The results are presented in Table 1.3. All coefficients on the various elasticities interacted with $IP(Importer)$ are negative and significant in 4 out of 6 specifications and all coefficients on $\sigma(Importer)$ are positive and significant in 5 out of 6 specifications.

Using the importer elasticities (first two columns), the results imply that, relative to countries with the lowest IPR strength, countries with the strongest IPRs observe a .124% lower import value for every one standard deviation increase in demand elasticity. Restricting the sample to more sensible elasticity estimates, this effect increases to a 1.74% lower import value for every one standard deviation increase in demand elasticity.

Using the exporter elasticities (middle two columns), the results show that, relative to countries with the lowest IPR strength, countries with the strongest IPRs see a .038% lower import value for every one standard deviation increase in demand elasticity. Restricting the sample to more sensible elasticity estimates, this effect increases to a 2.319% lower import value for every one standard deviation increase in demand elasticity.

Using the computed trade-weighted elasticities (last two columns), the results also imply that, relative to countries with the lowest IPR strength, countries with the strongest IPRs observe a .831% lower import value for every one standard deviation increase in demand elasticity. Restricting the sample to more sensible elasticity estimates, this effect increases to a 2.633% lower import value for every one standard deviation increase in demand elasticity, though this estimate is statistically insignificant.

The results arising from the 3 different specifications speak to the fact that the choice of which market's product elasticities to use affects the magnitude but not the direction of the effects. More inelastically demanded goods appear to enjoy a higher amount of trade in strong IPR conditions relative to more elastic goods, regardless of the choice of which country's product elasticity estimates are used. In terms of magnitude, this effect appears dependent upon the relative weights exporters place on the importance of different markets within their trading portfolios.

High Exporter IP Sample Since IPRs are likely to affect primarily origin countries that already have strong IPRs, I also estimate (2) for the sample restricted to exporters with IPR strength indices above the 50th percentile of the sample, for a conservative estimate. I again run the estimation with 3 specifications: $\sigma(Importer)$, $\sigma(Exporter)$ and $\sigma(Trade-weighted)$, each interacted with the IP index.

The results are shown in Table 1.4. All coefficients on the various elasticities interacted with $IP(Importer)$ are negative and all are significant but for one specification and all coefficients on $\sigma(Importer)$ are positive but significant in 4 of 6 specifications.

Using the importer elasticities (first two columns), the results imply that, relative to countries with the lowest IPR strength, countries with the strongest IPRs see a .222% lower import value for every one standard deviation increase in demand elasticity. Restricting the sample to more sensible elasticity estimates, this effect increases to a 2.058% lower import value for every one unit increase in demand elasticity.

Using the exporter elasticities (middle two columns), the results show that, relative to countries with the lowest IPR strength, countries with the strongest IPRs observe a .017%

lower import value for every one standard deviation increase in demand elasticity. Restricting the sample to more sensible elasticity estimates, this effect increases to a 3.235% lower import value for every one standard deviation increase in demand elasticity.

Using the computed trade-weighted elasticities (last two columns), the results imply that, relative to countries with the lowest IPR strength, countries with the strongest IPRs observe a .158% lower import value for every one standard deviation increase in demand elasticity. Restricting the sample to more sensible elasticity estimates, this effect increases to a 1.203% lower import value for every one standard deviation increase in demand elasticity.

Again, the results from the 3 different estimations highlight the fact that the directional effect of inelastically demanded goods seeing a greater positive impact from strong IPRs relative to more elastic goods, though the magnitude can vary depending upon the relative importance placed on different markets.

Rauch Classification Sample One might be interested only in the subset of goods which are objectively classified as differentiated. Rauch (1999) constructed a classification system of goods by SITC 4-digit Rev. 2 product codes into 3 categories: Homogeneous, Reference-Priced and Differentiated. I match the bilateral data at the product-level to these Rauch indicators. I then estimate (2) for both the sample (i) excluding Rauch Homogeneous goods and (ii) excluding Rauch Homogeneous and Reference-Priced goods (leaving only Rauch Differentiated products). Again, because Rauch's classification is based on U.S. products and classifications can differ considerably across countries, this approach must be interpreted with caution. Thus, it is still useful to consider results without improbably high elasticity estimates. The results are shown in Table 1.5, with results for (i) in the first two columns and results for (ii) in the last two columns.

The coefficients on $\sigma(Importer) \times IP(Importer)$ are both negative and significant and imply that, relative to countries with the lowest IPR strength, countries with the strongest IPRs observe a .127% and a .133% lower import value, respectively, of higher relative to lower elasticity goods that differ by one standard deviation. Restricting the sample to the 95th percentile of elasticity estimates, this effect increases to, respectively, a 1.96% and 2.26% lower import value for every one standard deviation increase in demand elasticity. The coefficients on $\sigma(Importer)$ are both positive and significant, implying, as before, that higher elasticity goods are unconditionally more likely to be traded.These results are, again, consistent in sign with the previous cross-sectional results for other samples. The difference in magnitude is also only marginal.

Let us now briefly consider other potential explanations for the empirical evidence. It could be that products with a higher productivity gap between exporter and importer are

Table 1.6. Timing of Major Patent Reforms

Country	Year of Reform	Pre-Reform	Post-Reform
Argentina	1996	1991-1995	1997-2001
Brazil	1997	1992-1996	1998-2002
China	1993	1900-1992	1994-1996
Colombia	1994	1990-1993	1995-1998
Turkey	1995	1990-1992	1998-2000
Venezuela	1994	1990-1993	1995-1998

goods that are both more likely to be sensitive to IP regimes and more likely to be inelastically demanded in the destination. Then, the result is somewhat built in. It could also be that an IP reform itself is triggered by a structural change in demand towards more inelastically demanded goods. However, this does not quite get at why the cross-sectional impact across countries should vary.

1.6.3 Panel Evidence

Panel analysis was conducted for the following six reforms, Table 1.6, documented in Branstetter et al. (2006):

The choice of these 6 reforms out of the original 15 national IP reforms documented in Branstetter et al. (2006) came down to the availability of an adequate panel length of at least 3 years pre- and post-reform, as well as the availability of country-product-level demand elasticities as estimated by Broda, Greenfield and Weinstein (2006). I estimate a panel difference-in-difference model of whether products of differing elasticity are differentially impacted by a reform. Defining the Pre-Reform period conservatively, I use all country-product observations from the years immediately before the reform; this amounts to between 3-5 years worth of the sample defined as Pre-Reform. Similarly defining the Post-Reform period conservatively, I use all observations in years immediately following a reform, resulting in 3-5 years worth of each sample defined as Post-Reform.

Panel Analysis by Country

For each reforming importing country i, I estimate :

$$\ln(Imports_{xjt}) = \beta_0 + \beta_1 \sigma_j(Importer) \times Reform_t + \beta_2 Reform_t + \mu_x + \mu_j + \mu_x \times Reform_t + \varepsilon_{xjt}$$

where $Imports_{xjt}$ are the imports of product j from x in period t, σ_j is country i's demand elasticity for product j, $Reform_t$ is an indicator for the Post-Reform period, μ_x is a set of exporter fixed-effects and μ_j are product fixed-effects. The $\mu_x \times Reform_t$ control captures potential differences in how individual exporting countries may react to the destination country reform. Results without this added control are identical in all substantive respects.

Tables 1.7.1 and 1.7.2 give the individual country estimation results for the six reforming countries, both for the full country sample and for the sample excluding the top 5% of import goods based on elasticity. This exclusion is again based on the idea that exceptionally high import elasticities (reaching a value over 1500 at its max) may point to either measurement error in the initial elasticity estimate (see Broda, Weinstein and Greenfield 2006 for estimation details) or an extremely high degree of product homogeneity unlikely to be affected by any IP reforms.

The individual results consistently show that, not surprisingly, the IP reforms themselves contribute positively and significantly in increasing bilateral imports. The primary coefficients of interest here, those on $\sigma(Importer) \times Reform$, can be interpreted as the differential trade impact of the IP reform on more elastically demanded goods relative to more inelastically demanded ones. Those coefficients are mostly negative, suggesting that, following an IP reform, more inelastic goods are more often imported relative to more elastically demanded goods, however none are statistically significant.

Pooled Panel Analysis

Pooling together all six country-level reforms, I estimate the following:

$$\ln(Imports_{ixjt}) = \beta_0 + \beta_1 \sigma_{ij}(Importer) \times Reform_{it} + \beta_2 Reform_{it} + \mu_{ix} + \mu_j + \varepsilon_{ixjt}$$

where $Imports_{ixjt}$ are the imports of product j from x to i in period t, σ_{ij} is country i's demand elasticity for product j, $Reform_t$ is an indicator for the Post-Reform period, μ_{ix} is a set of bilateral fixed-effects and μ_j are product fixed-effects.

Table 1.8 presents the results of estimating (3) using pooled data from all 6 IP reforms to test the combined effect of the IP reforms. Here, again, I find that the reform has a significant positive impact on bilateral imports. The coefficients on $\sigma_{ij}(Importer) \times Reform_{it}$ remain negative for both the full and 95-percentile samples, but is only significant in the 95-percentile sample. The negative signs again suggest that IP reforms have a greater impact in increasing imports of inelastically demanded products relative to elastically demanded ones.

To summarize, evidence in the panel data appears to support the cross-sectional results, but are generally not significant on the $\sigma_{ij}(Importer) \times Reform_{it}$ coefficient, except in the pooled 95 percentile sample. The reform variable itself appears to have a significant and positive impact on import value in every specification.

1.7 Conclusion: Linking Theory and Empirics

In this paper, I outlined a theoretical framework with which to analyze the effect of intellectual property rights on the composition of trade and welfare. The model is based on consumer preferences over differentiated products uniquely identified by their individual demand elasticities and explores whether and how IPRs affect the set and composition of goods traded.

A main conclusion of the theoretical section is that relatively inelastically demanded products should be more often exported to stronger IPR destinations relative to weaker ones. This is driven by consumer preferences allowing for differing demand elasticities across goods. Relatively inelastically demanded goods translate into higher profits for the firms associated with those products, ceteris paribus, and thus higher incentives to protect those products under threat of IP piracy. In the empirical section, I documented this to be robustly the case across various subsamples of the cross-sectional data and broadly supported by panel data as well.

A second insight of the theoretical section is that imports of relatively homogeneous or elastically demanded goods should not be impacted by destination IPRs, even if they are among the "differentiated" products as opposed to the entirely homogeneous goods. Those are the products for which the profit margin is low enough due to the exporters' higher productivity relative to destination-country firms, that imitation is not profitable. Empirically, this is also supported in both the cross-section and the panel when comparing the full sample to samples excluding the top 5% most demand elastic products or Rauch "reference-priced" goods.

A third insight of the theory is related to destination market size. If the destination market is a big enough share of an exporter's trade portfolio relative to the risk of IP piracy faced by the product, destination IPRs should also not matter for the firm export decision. Although the bilateral fixed effects in the empirical section prevent direct exploration of the destination size effect, anecdotal evidence on the large import variety enjoyed by frequent IPR violators such as China and India appears generally to support this.

Standard trade theory assumes a CES utility function with constant markups for which only the number of varieties matters for consumers' taste for variety. In that environment, firms of comparable productivity should adjust in the same way to threats of IP piracy on profits, regardless of which variety they produce. Therefore, trade composition should be symmetrically affected across varieties and welfare harmed via only the classical number of varieties channel. In Proposition 2, I showed that this is not the case when consumer preferences, and thus demand elasticities, differ across products. The data also support the idea that effects on trade composition are asymmetric across varieties.

Welfare is found in the theory to be potentially non-monotonic in IPR protection for both North and South. The results differ from the current literature in the following respects: (1) the developing South has the potential to gain from tightened IPRs even in the short-run, via the additional channel of gaining varieties for which it possesses more inelastic demand, (2) welfare in the North trades off static consumer and producer welfare and is also ambiguously affected by stronger IPRs in the South, and (3) there is the possibility of compatible short-run incentives and the existence of an optimal IPR level even ignoring long-run innovation effects. An important implication is that when a developing country is small in terms of consumer market share, has high IP piracy rates, or both, its stands to lose the availability of goods its consumers care the most about.

Further work could be done to extend the model. One major technical issue that prevents analytical quantification of welfare effects is the unspecified process of the piracy probability, ρ. Because this probability is exogenous and piracy can target any variety with equal probability, regardless of its profit potential, it is not possible to precisely characterize the set of pirated products and thus determine net welfare effects. In particular, it would be beneficial to explore the case when pirates target a convex range of goods, so that analytical characterization of the pirated set n_S is possible. Another possible consideration would be to include the effect of IPR protection on the Northern innovation process, which would require laying out the innovation process more carefully and exploring dynamic, longer run effects. Under interpretations of South as a small developing country this may make less sense than if South is interpreted as a large country that can affect the world market.

While several of the empirical findings are consistent with the framework of varying consumer preferences and IP piracy risk, there is much more that can be done. An ideal test of whether consumer preferences are the underlying mechanism is to control for potential exporter variance by using firm-product-level data that can account for productivity and other exporter-level differences. Such data are not readily available. Further research on the underlying mechanisms driving asymmetric trade composition effects as well as potentially better functional forms for preferences capturing the essence of differing preference over variety is needed, but beyond the scope of this paper.

1.8 Mathematical Appendix

Proof. Closed Economy Northern Price Index Derivation

The ideal price index in the North can be represented by the solution to the expenditure minimization problem

$$\min p_0 q_0 + \int_1^J p_j q_j dj$$
$$\text{s.t. } u = q_0 + \int_1^J \theta_j q_j^{\frac{1}{\theta_j}} dj = 1$$

with the associated first order condition

$$q_j = \left(\frac{p_j}{p_0}\right)^{\frac{\theta_j}{1-\theta_j}}$$
$$\Rightarrow q_0 = 1 - \int_1^J \theta_j \left(\frac{p_j}{p_0}\right)^{\frac{1}{1-\theta_j}} dj$$

Thus the price index is given by

$$\mathbf{P} = p_0 - p_0^{\frac{\theta_j}{\theta_j - 1}} \int_1^J \theta_j p_j^{\frac{1}{1-\theta_j}} dj + \int_1^J p_0^{\frac{\theta_j}{\theta_j-1}} p_j^{\frac{1}{1-\theta_j}} dj$$

Plugging in the monopoly price $p_j^N = \theta_j$ and normalizing the price of the homogeneous good $p_0 = 1$, we have

$$\mathbf{P} = 1 - \int_1^J \theta_j^{\frac{2-\theta_j}{1-\theta_j}} dj + \int_1^J \theta_j^{\frac{1}{1-\theta_j}} dj$$

■

Proof. Proposition 1.2

(Existence)

First note that no Northern firm would choose to export under threat of piracy if $w_S + \phi \leq w_N$ when $\frac{L_S}{\omega L_N + L_S} < \rho$ as this would generate negative expected export premium

$$\Delta = \left[(\theta_j - 1)\, \theta_j^{\frac{\theta_j}{1-\theta_j}} \left[\frac{L_S}{\omega L_N + L_S} - \rho \right] + \rho \cdot \max\{w_S + \phi - 1, 0\}\, (w_S + \phi)^{\frac{\theta_j}{1-\theta_j}} \right] (\omega L_N + L_S) < 0$$

So in order for any Northern firm to export when $\frac{L_S}{\omega L_N + L_S} < \rho$ we need $w_S + \phi > w_N = 1$, so that we can restrict attention to

$$\Delta = \left\{ \begin{array}{c} (\theta_j - 1)\, \theta_j^{\frac{\theta_j}{1-\theta_j}} L_S \\ \text{if } \theta_j \leq w_S + \phi \\ \left[(\theta_j - 1)\, \theta_j^{\frac{\theta_j}{1-\theta_j}} \left[\frac{L_S}{\omega L_N + L_S} - \rho \right] + \rho \cdot (w_S + \phi - 1)\, (w_S + \phi)^{\frac{\theta_j}{1-\theta_j}} \right] (\omega L_N + L_S) \\ \text{if } \theta_j > w_S + \phi \end{array} \right\}$$

In order for there to exist such a cutoff, we need the export premium to be positive for lower values of θ_j and negative as $\theta_j \to \infty$. Since we focus on the case where $w_S + \phi > w_N = 1 \Rightarrow \exists$ some $\theta_j > 1$ such that $\theta_j \leq w_S + \phi$. This means that $\Delta = (\theta_j - 1)\,\theta_j^{\frac{\theta_j}{1-\theta_j}} L_S > 0$ for the lowest values of θ_j in the domain $\theta_j > 1$, where $\theta_j \leq w_S + \phi$.

The limit of Δ as θ_j eventually increases such that $\theta_j > w_S + \phi$ is given by $\lim_{\theta_j \to \infty} \Delta = \left[\frac{L_S}{\omega L_N + L_S} - \frac{\rho}{w_S + \phi}\right](\omega L_N + L_S)$. So to ensure that the export premium, which was initially positive for low values of θ_j, eventually becomes negative for the high values of θ_j, we need $\left[\frac{L_S}{\omega L_N + L_S} - \frac{\rho}{w_S + \phi}\right](\omega L_N + L_S) < 0 \Rightarrow (w_S + \phi)\frac{L_S}{\omega L_N + L_S} < \rho$ where $(w_S + \phi)\frac{L_S}{\omega L_N + L_S}$ is the relative marginal gain to a Northern firm of exporting when their product is pirated.

Since $\frac{\partial \Delta}{\partial \theta_j}$ exists, we know Δ is a continuous function, thus, invoking the Intermediate Value Theorem, we know that there must exist a critical point $\hat{\theta}_j$ such that $\Delta\left(\hat{\theta}_j\right) = 0$, where $\Delta > 0$ for some range $(\underline{\theta}, \hat{\theta}_j]$ and $\Delta < 0$ for some range $(\hat{\theta}_j, \bar{\theta})$.

(Uniqueness)

We know $\Delta > 0$ for lower values of θ_j and that it is continuous on the entire domain. Since $\frac{\partial \pi^M}{\partial \theta_j} > 0$ and $\Delta = \pi^M L_S$ for $\theta_j \leq w_S + \phi$, we know that Δ is monotone increasing in that range. Thus, if under the conditions $\theta_j > w_S + \phi$ when $w_S + \phi > w_N = 1$ and $(w_S + \phi)\frac{L_S}{\omega L_N + L_S} < \rho$, we have that when $\Delta > 0$ for some θ', it is positive-valued for all $\theta_j < \theta'$ and once $\Delta < 0$ for some θ^*, it is negative-valued for all θ_j thereafter, then uniqueness of the critical cutoff follows. Let us denote $\Delta_2 \equiv \left[(\theta_j - 1)\,\theta_j^{\frac{\theta_j}{1-\theta_j}}\left[\frac{L_S}{\omega L_N + L_S} - \rho\right]\right](\omega L_N + L_S) + \left[\rho \cdot (w_S + \phi - 1)(w_S + \phi)^{\frac{\theta_j}{1-\theta_j}}\right](\omega L_N + L_S)$, the value of Δ when $\theta_j > w_S + \phi$.

$$
\begin{aligned}
\Delta &> 0 \\
&\Rightarrow \rho \cdot (w_S + \phi - 1)(w_S + \phi)^{\frac{\theta_j}{1-\theta_j}} > (\theta_j - 1)\,\theta_j^{\frac{\theta_j}{1-\theta_j}}\left[\frac{L_S}{\omega L_N + L_S} - \rho\right] \\
&\Rightarrow \frac{\rho \cdot (w_S + \phi - 1)}{\frac{L_S}{\omega L_N + L_S} - \rho} > \frac{(\theta_j - 1)\,\theta_j^{\frac{\theta_j}{1-\theta_j}}}{(w_S + \phi)^{\frac{\theta_j}{1-\theta_j}}} = \frac{\pi^M}{q^C}
\end{aligned}
$$

Note that the LHS of the inequality is constant. Let $RHS = \frac{\pi^M}{q^C}$; taking the FOC of RHS

$$
\begin{aligned}
\frac{\partial RHS}{\partial \theta_j} &= \frac{q^C \partial \pi^M - \pi^M \partial q^C}{\left(q^C\right)^2} \\
&= \frac{(w_S+\phi)^{\frac{\theta_j}{1-\theta_j}} \left[\begin{array}{c} \left(\frac{1}{\theta_j(1-\theta_j)} + \frac{1}{(1-\theta_j)^2}\ln\theta_j\right)\theta_j^{\frac{1}{1-\theta_j}} \\ -\left(\frac{1}{1-\theta_j} + \frac{1}{(1-\theta_j)^2}\ln\theta_j\right)\theta_j^{\frac{\theta_j}{1-\theta_j}} \end{array}\right] - (\theta_j-1)\,\theta_j^{\frac{\theta_j}{1-\theta_j}} \left[\begin{array}{c} (w_S+\phi)^{\frac{\theta_j}{1-\theta_j}} \\ \cdot \left[\frac{\ln(w_S+\phi)}{(1-\theta_j)^2}\right] \end{array}\right]}{(w_S+\phi)^{\frac{2\theta_j}{1-\theta_j}}}
\end{aligned}
$$

$$
\begin{aligned}
-\ln\theta_j &< -\ln(w_S+\phi) \\
\frac{\theta_j}{1-\theta_j}\ln\theta_j - \frac{1}{1-\theta_j}\ln\theta_j &< -\ln(w_S+\phi) \\
1 + \frac{\theta_j}{1-\theta_j}\ln\theta_j - \left(1 + \frac{1}{1-\theta_j}\ln\theta_j\right) &< -\ln(w_S+\phi) \\
\left(\frac{1}{\theta_j} + \frac{1}{1-\theta_j}\ln\theta_j\right)\theta_j - \left(1 + \frac{1}{1-\theta_j}\ln\theta_j\right) &< (\theta_j-1)\left[\frac{\ln(w_S+\phi)}{1-\theta_j}\right] \\
\left(\frac{1}{\theta_j(1-\theta_j)} + \frac{1}{(1-\theta_j)^2}\ln\theta_j\right)\theta_j - \left(\frac{1}{1-\theta_j} + \frac{1}{(1-\theta_j)^2}\ln\theta_j\right) &> (\theta_j-1)\left[\frac{\ln(w_S+\phi)}{(1-\theta_j)^2}\right] \\
\left[\begin{array}{c} \left(\frac{1}{\theta_j(1-\theta_j)} + \frac{1}{(1-\theta_j)^2}\ln\theta_j\right)\theta_j^{\frac{1}{1-\theta_j}} \\ -\left(\frac{1}{1-\theta_j} + \frac{1}{(1-\theta_j)^2}\ln\theta_j\right)\theta_j^{\frac{\theta_j}{1-\theta_j}} \end{array}\right] &> \left[\begin{array}{c} (\theta_j-1)\,\theta_j^{\frac{\theta_j}{1-\theta_j}} \\ \cdot\left[\frac{\ln(w_S+\phi)}{(1-\theta_j)^2}\right] \end{array}\right] \\
&\Rightarrow \frac{\partial RHS}{\partial \theta_j} > 0
\end{aligned}
$$

Since RHS is increasing in θ_j, if $\Delta > 0$ for some θ', we know it will be positive-valued for all $\theta_j < \theta'$. Alternatively

$$
\begin{aligned}
\Delta &< 0 \\
&\Rightarrow \rho\cdot(w_S+\phi-1)(w_S+\phi)^{\frac{\theta_j}{1-\theta_j}} < (\theta_j-1)\,\theta_j^{\frac{\theta_j}{1-\theta_j}}\left[\frac{L_S}{\omega L_N + L_S} - \rho\right] \\
&\Rightarrow \frac{\rho\cdot(w_S+\phi-1)}{\frac{L_S}{\omega L_N+L_S} - \rho} < \frac{(\theta_j-1)\,\theta_j^{\frac{\theta_j}{1-\theta_j}}}{(w_S+\phi)^{\frac{\theta_j}{1-\theta_j}}} = \frac{\pi^M}{q^C}
\end{aligned}
$$

Again, knowing the LHS is constant and that RHS is increasing in θ_j, if $\Delta < 0$ for some θ^*, it will remain negative-valued for all θ_j thereafter. Thus, single crossing obtains. ■

Proof. Derivation of Open Economy Price Index in South

The price index in South is given by

$$
\begin{aligned}
\mathbf{P}^S &= p_0 - \int_1^{J^S} \theta_j p_0^{\frac{\theta_j}{\theta_j-1}} p_j^{\frac{1}{1-\theta_j}} dj + \int_1^{J^S} p_0^{\frac{\theta_j}{\theta_j-1}} p_j^{\frac{1}{1-\theta_j}} dj \\
&= p_0 - \int_{j\in n_N} \theta_j p_0^{\frac{\theta_j}{\theta_j-1}} p_j^{\frac{1}{1-\theta_j}} dj - \int_{j\in n_S} \theta_j p_0^{\frac{\theta_j}{\theta_j-1}} p_j^{\frac{1}{1-\theta_j}} dj + \int_{j\in n_N} p_0^{\frac{\theta_j}{\theta_j-1}} p_j^{\frac{1}{1-\theta_j}} dj \\
&\quad + \int_{j\in n_S} p_0^{\frac{\theta_j}{\theta_j-1}} p_j^{\frac{1}{1-\theta_j}} dj
\end{aligned}
$$

Note that for $j \in n_N$, $p_j = \theta_j$ and for $j \in n_S$, $p_j^S = \gamma_0^S + \phi$. Plugging in these and the Southern competitive price $p_0 = p_j^S = \gamma_0^S + \phi$ (full derivation in Mathematical Appendix) we have

$$
\begin{aligned}
\mathbf{P}^S &= \gamma_0^S + \phi - \int_{j\in n_N} \theta_j \left(\gamma_0^S + \phi\right)_j^{\frac{\theta_j}{\theta_j-1}} \theta_j^{\frac{1}{1-\theta_j}} dj - \int_{j\in n_S} \theta_j \left(\gamma_0^S + \phi\right) dj \\
&\quad + \int_{j\in n_N} \left(\gamma_0^S + \phi\right)^{\frac{\theta_j}{\theta_j-1}} \theta_j^{\frac{1}{1-\theta_j}} dj + \int_{j\in n_S} \left(\gamma_0^S + \phi\right) dj \\
\mathbf{P}^S &= \gamma_0^S + \phi - \int_{j\in n_N} \theta_j \left(\gamma_0^S + \phi\right)_j^{\frac{\theta_j}{\theta_j-1}} \theta_j^{\frac{1}{1-\theta_j}} dj - \left(\gamma_0^S + \phi\right) \int_{j\in n_S} \theta_j dj \\
&\quad + \int_{j\in n_N} \left(\gamma_0^S + \phi\right)^{\frac{\theta_j}{\theta_j-1}} \theta_j^{\frac{1}{1-\theta_j}} dj + n_S \left(\gamma_0^S + \phi\right) \\
\mathbf{P}^S &= \left(1 + n_S - \int_{j\in n_S} \theta_j dj\right) \left(\gamma_0^S + \phi\right) - \int_{j\in n_N} \theta_j \left(\gamma_0^S + \phi\right)_j^{\frac{\theta_j}{\theta_j-1}} \theta_j^{\frac{1}{1-\theta_j}} dj \\
&\quad + \int_{j\in n_N} \left(\gamma_0^S + \phi\right)^{\frac{\theta_j}{\theta_j-1}} \theta_j^{\frac{1}{1-\theta_j}} dj \\
&= \left(1 + n_S - \int_{j\in n_S} \theta_j dj\right) \left(\gamma_0^S + \phi\right) + \int_{j\in n_N} (1 - \theta_j) \left(\gamma_0^S + \phi\right)_j^{\frac{\theta_j}{\theta_j-1}} \theta_j^{\frac{1}{1-\theta_j}} dj
\end{aligned}
$$

■

Proof. Derivation of Open Economy Price Index and Profit per-worker in North

Let $J^N = \{j : \Delta < 0\}$ be the set of goods not exported by North. The general form of the previous closed economy price index in North is reproduced below

$$
\mathbf{P}^N = p_0 - \int_1^{J} p_0^{\frac{\theta_j}{\theta_j-1}} \theta_j p_j^{\frac{1}{1-\theta_j}} dj + \int_1^{J} p_0^{\frac{\theta_j}{\theta_j-1}} p_j^{\frac{1}{1-\theta_j}} dj
$$

Plugging in the monopoly price $p_j^N = \theta_j$ for goods that are not exported and goods that are exported and not imitated $(J^N \cup n_N)$, in addition to the Southern competitive price

$p_j^S = \frac{\gamma_0^S}{\gamma_1^S} + \phi$ for goods that are exported and imitated, we have

$$\begin{aligned}
\mathbf{P}^N &= \gamma_0^S + \phi - \int_{j \in J^N \cup n_N} \theta_j p_j^{\frac{1}{1-\theta_j}} dj - \int_{j \in n_S} \theta_j p_j^{\frac{1}{1-\theta_j}} dj + \int_{j \in J^N \cup n_N} p_j{}^{\frac{1}{1-\theta_j}} dj + \int_{j \in n_S} p_j{}^{\frac{1}{1-\theta_j}} dj \\
&= \gamma_0^S + \phi - \int_{j \in J^N \cup n_N} \theta_j^{\frac{2-\theta_j}{1-\theta_j}} dj - \int_{j \in n_S} \theta_j \left(\gamma_0^S + \phi\right)^{\frac{1}{1-\theta_j}} dj + \int_{j \in J^N \cup n_N} \theta_j{}^{\frac{1}{1-\theta_j}} dj \\
&\quad + \int_{j \in n_S} \left(\gamma_0^S + \phi\right)^{\frac{1}{1-\theta_j}} dj \\
&= \gamma_0^S + \phi + \int_{j \in J^N \cup n_N} \theta_j{}^{\frac{1}{1-\theta_j}} - \theta_j^{\frac{2-\theta_j}{1-\theta_j}} dj + \int_{j \in n_S} (1-\theta_j) \left(\gamma_0^S + \phi\right)^{\frac{1}{1-\theta_j}} dj
\end{aligned}$$

Northern per-worker profits, under trade, are now

$$\begin{aligned}
\frac{\Pi_N}{L_N} &= \int_{j \in J^N} \pi_j^M dj + \int_{j \in n_N} \left(1 + \frac{L_S}{L_N}\right) \pi_j^M dj + \int_{j \in n_S} \left(1 + \frac{L_S}{L_N}\right) \pi_j^C dj \\
&= \int_{j \in J^N} \left[p_j^N q_j^M - w_N q_j^M\right] dj + \int_{j \in n_N} \left(1 + \frac{L_S}{L_N}\right) \left[p_j^N q_j^M - w_N q_j^M\right] dj \\
&\quad + \int_{j \in n_S} \left(1 + \frac{L_S}{L_N}\right) \left[p_j^S q_j^C - w_N q_j^C\right] dj \\
&= \int_{j \in J^N(t)} \left[\theta_j^{\frac{1}{1-\theta_j}} - \theta_j^{\frac{\theta_j}{1-\theta_j}}\right] dj + \int_{j \in n_N} \left(1 + \frac{L_S}{L_N}\right) \left[\theta_j^{\frac{1}{1-\theta_j}} - \theta_j^{\frac{\theta_j}{1-\theta_j}}\right] dj \\
&\quad + \int_{j \in n_S} \left(1 + \frac{L_S}{L_N}\right) \left(\gamma_0^S + \phi - 1\right) \left(\gamma_0^S + \phi\right)^{\frac{\theta_j}{1-\theta_j}} dj
\end{aligned}$$

■

1.9 Data Appendix

HS 3-digit level product descriptions

HS3	N	Percent	σ(average)	Description
10	1,262	0.49	16.658	Live Animals
20	4,268	1.65	8.529	Fresh, Chilled, Frozen Meat
21	376	0.15	51.324	Meat of bovine and swine
30	4,396	1.7	8.151	Seafood
40	2,374	0.92	6.276	Animal Byproducts (Eggs, milk, etc.)
71	2,246	0.87	6.150	Dried/Frozen Beans and Vegetables
80	364	0.14	7.878	Nuts and Fresh Fruit
81	1	0	2.601	Dried/Preserved Fruits
90	10,038	3.89	7.590	Tea, coffee and seasonings
91	1,877	0.73	9.503	Spices
120	2,688	1.04	5.738	Edible Seeds
121	1,281	0.5	6.011	Roots and Vegetable products
130	820	0.32	7.211	Pectin substances and Gum
140	419	0.16	9.767	Raw vegetable materials
150	1,538	0.6	5.855	Animal Fats and Oils
151	4,104	1.59	7.120	Vegetable Fats and Oils
160	3,201	1.24	6.374	Meat and Seafood preparations
170	7,353	2.85	6.370	Glucose, fructose, cane, molasses
190	979	0.38	8.224	Couscous, flour, pasta, cereals
200	1,228	0.48	6.893	Fruit juices and preserves
210	1,007	0.39	5.170	Yeasts, meal, flour, sauces
230	1,298	0.5	21.224	Other vegetable materials
240	1,374	0.53	14.156	Cigarettes and Tobacco
250	1,255	0.49	5.130	Crude sulphur, silica, graphite, sodium
252	1,148	0.44	4.463	Cement and lime products
270	425	0.16	10.822	Coal, tar, peat, etc.
284	723	0.28	5.439	Aluminates, silicates, Manganites, chromates
290	764	0.3	3.211	Benzene, Butene, etc.
291	1,334	0.52	3.601	Acetone, Carboxylic acids, etc.
292	3,391	1.31	3.608	Amino-acids, etc.
293	2,948	1.14	9.676	Compounds containing chemicals
320	3,727	1.44	5.363	Pigments and preparations based on chemicals
321	1,459	0.56	3.684	Ink
330	5,266	2.04	4.279	Essential oils, makeup, personal products
340	4,922	1.91	3.783	Waxes and polishes
360	427	0.17	7.314	Prepared explosives, powders, fuses
381	1,050	0.41	5.658	Chemical elements and preparations
390	1,809	0.7	4.625	Resins and polymers
391	2,832	1.1	4.150	Cellulose products
392	3,786	1.47	3.496	Houseware (doors, tableware, etc.)

401	3,958	1.53	3.962	Rubber products
410	2,537	0.98	12.464	Leather products
420	2,021	0.78	3.610	Leather, catgut apparel and accessories
430	3	0	5.405	Fur apparel and accessories
440	1,183	0.46	4.321	Wood products
441	3,733	1.45	4.774	Plywood products
460	728	0.28	4.476	Plaiting materials
470	601	0.23	6.892	Chemical pulp
481	3,465	1.34	5.212	Paper products
482	1,917	0.74	5.210	Stationary materials
490	1,482	0.57	5.454	Print products
500	957	0.37	12.859	Woven fabrics of silk
510	979	0.38	14.926	Wool and yarn products
520	1,833	0.71	5.736	Thread
530	1,409	0.55	9.183	Flax, jute yarn, etc.
551	1,293	0.5	5.145	Woven fabrics
580	2,034	0.79	5.952	Narrow woven fabrics
600	1,614	0.62	6.116	Knitted or crocheted fabrics
610	4,233	1.64	3.958	Apparel
611	9	0	2.208	Apparel accessories
844	1,169	0.45	12.545	Machines for moulding articles, weaving, printing, etc.
845	878	0.34	7.802	Automatic sewing machines, milling, washing, cleaning, etc.
846	4,223	1.63	8.803	Automatic typewriters and word-processorcs, machine tools
847	2,424	0.94	4.676	Machinery for calculating, assembling, moulding, treating, etc.
848	3	0	9.911	Bearings, moulds, etc.
850	1,477	0.57	7.485	Generators
851	4,988	1.93	4.121	Electro-thermic appliances, Sound reproducing and telephonic apparatus
852	5,623	2.18	7.658	Magnetic, radio, transmission appliances
853	4,480	1.73	5.255	Electrical capacitors, resistors, etc.
854	8,446	3.27	3.827	Electric conductors, Semiconductor devices, etc.
860	169	0.07	25.334	Rail locomotives, cars, parts
870	7,109	2.75	33.694	Automobiles and parts
871	1,209	0.47	9.574	Vehicle parts and other vehicles
880	1,465	0.57	24.161	Aircraft propellers and rotors, Helicopters
890	327	0.13	18.344	Motorboats, marine vessels
901	3,942	1.53	5.514	Apparatus and equip for automatical measurement
902	6,178	2.39	6.013	Apparatus based on the use of X-ray
903	2,309	0.89	5.908	Automatic regulating or controlling instruments
940	944	0.37	4.205	Articles of bedding/furnishing

Table 1.1. Descriptive Statistics - Full Bilateral Sample

Variable	*N*	*μ*	*s.d.*	*min*	*max*
ln(Imports)	337280	7480387	1.13E+08	1	1.88E+10
Imports	337280	10.99507	3.454641	0	23.65574
SITC2	337280	6.15E+03	2384.015	1.30E+01	8974
HS3	337280	545.6231	291.203	10	940
σ(Importer)_unnormalized	337280	7.24E+00	2.52E+01	1.07E+00	1560.588
σ(Importer)	337280	-6.76E-11	1	-0.24465	61.67168
IP(Importer)_unnormalized	337280	3.978771	0.643751	2.15	4.88
IP(Importer)	337280	0.7957542	0.12875	0.43	0.976
σ(Importer)*IP(Importer)	337280	-0.001552	0.852535	-0.23445	53.40768
IP(Exporter)	337280	4.034125	0.68358	0.2	4.88
σ(Exporter)_unnormalized	258323	7.074829	28.64071	1.074257	1560.588
σ(Exporter)	258323	3.87E-10	1	-0.20951	54.24144
σ(Exporter)*IP(Importer)	258323	0.0010504	0.806703	-0.20448	50.6615
σ(Trade-weighted)_unnormalized	251810	27.77516	208.895	0.050498	2775.808
σ(Trade-weighted)	251810	-1.36E-09	1	-0.13272	13.15509
σ(Trade-weighted)*IP(Importer)	251810	-0.009503	0.667371	-0.12848	11.94482

Table 1.2. Import Data: Full & 95pc Sample Estimations

	Full	95 %ile
ln(Imports)	*β/se*	*β/se*
σ(Importer)	0.059*	0.248
	(0.03)	(0.17)
σ(Importer)*IP(Importer)	-0.113*	-0.447*
	(0.06)	(0.19)
Constant	6.192***	6.182***
	(0.14)	(0.14)
Product FEs	Yes	Yes
Country FEs	Yes	Yes
R^2	0.485	0.485
N	406094	384575

* p<0.05, ** p<0.01, *** p<0.001

Table 1.3. Bilateral Import Data: Full & 95pc Sample Estimations

	Full	95 %ile	Full	95 %ile	Full	95 %ile
ln(Imports)	*β/se*	*β/se*	*β/se*	*β/se*	*β/se*	*β/se*
σ(Importer)	0.099**	1.228***				
	(0.03)	(0.36)				
σ(Importer) *IP(Importer)	-0.124**	-1.739***				
	(0.04)	(0.45)				
σ(Exporter)			0.050	2.287***		
			(0.04)	(0.54)		
σ(Exporter) *IP(Importer)			-0.038	-2.319***		
			(0.04)	(0.67)		
σ(Trade-weighted)					1.130***	7.142***
					(0.29)	(1.96)
σ(Trade-weighted) *IP(Importer)					-0.831*	-2.633
					(0.35)	(2.45)
Constant	11.494***	11.424***	11.740***	11.612***	11.674***	11.890***
	(0.08)	(0.09)	(0.09)	(0.10)	(0.09)	(0.10)
Product FEs	Yes	Yes	Yes	Yes	Yes	Yes
Bilateral FEs	Yes	Yes	Yes	Yes	Yes	Yes
R^2	0.379	0.380	0.381	0.386	0.398	0.384
N	337280	320295	258323	245345	251810	238956

* p<0.05, ** p<0.01, *** p<0.001

Table 1.4. High Exporter IP Protection Sample Estimation

	Full	95 %ile	Full	95 %ile	Full	95 %ile
ln(Imports)	*β/se*	*β/se*	*β/se*	*β/se*	*β/se*	*β/se*
σ(Importer)	0.184***	1.539**				
	(0.05)	(0.50)				
σ(Importer) *IP(Importer)	-0.222***	-2.058***				
	(0.06)	(0.62)				
σ(Exporter)			-0.001	1.848*		
			(0.04)	(0.85)		
σ(Exporter) *IP(Importer)			-0.017	-3.235**		
			(0.05)	(1.05)		
σ(Trade-weighted)					0.086	0.802**
					(0.05)	(0.31)
σ(Trade-weighted) *IP(Importer)					-0.158**	-1.203**
					(0.06)	(0.37)
Constant	11.483***	11.426***	11.765***	11.871***	11.766***	11.805***
	(0.09)	(0.10)	(0.11)	(0.13)	(0.11)	(0.13)
Product FEs	Yes	Yes	Yes	Yes	Yes	Yes
Bilateral FEs	Yes	Yes	Yes	Yes	Yes	Yes
R^2	0.420	0.422	0.446	0.451	0.448	0.449
N	164226	156014	107582	102195	105415	100005

* p<0.05, ** p<0.01, *** p<0.001

Table 1.5. Rauch Non-Homogeneous Sample Estimation

	(1)	95 %ile	(2)	95 %ile
ln(Imports)	*β/se*	*β/se*	*β/se*	*β/se*
σ(Importer)	0.010*	1.273*	0.109*	1.539**
	(0.05)	(0.53)	(0.05)	(0.54)
σ(Importer)*IP(Importer)	-0.127*	-1.956**	-0.133*	-2.260***
	(0.05)	(0.65)	(0.06)	(0.68)
Constant	10.579***	10.507***	10.494***	10.423***
	(0.11)	(0.13)	(0.12)	(0.13)
Product FEs	Yes	Yes	Yes	Yes
Bilateral FEs	Yes	Yes	Yes	Yes
R^2	0.409	0.410	0.451	0.452
N	203982	193983	161289	153099

* p<0.05, ** p<0.01, *** p<0.001

Table 1.7.1 Panel Difference-in-Difference Estimations

	Argentina	95 %ile	Brazil	95 %ile	China	95 %ile
ln(Imports)	*β/se*	*β/se*	*β/se*	*β/se*	*β/se*	*β/se*
σ(Importer) *Reform	-0.020	-0.191	-0.029	0.190	-0.026	-0.475
	(0.02)	(0.20)	(0.02)	(0.31)	(0.04)	(0.37)
Reform	0.462***	0.420**	0.368***	0.400***	0.431*	0.344
	(0.13)	(0.15)	(0.11)	(0.12)	(0.17)	(0.19)
Constant	10.695***	10.741***	11.686***	8.923***	9.622***	9.817***
	(0.45)	(0.46)	(0.37)	(0.80)	(0.40)	(0.43)
Exporter*Reform	Yes	Yes	Yes	Yes	Yes	Yes
Product FEs	Yes	Yes	Yes	Yes	Yes	Yes
Bilateral FEs	Yes	Yes	Yes	Yes	Yes	Yes
R^2	0.116	0.110	0.148	0.151	0.200	0.207
N	41734	38468	45907	43118	27350	25881

* p<0.05, ** p<0.01, *** p<0.001

Table 1.7.2 Panel Difference-in-Difference Estimations

	Colombia	95 %ile	Turkey	95 %ile	Venezuela	95 %ile
ln(Imports)	*β/se*	*β/se*	*β/se*	*β/se*	*β/se*	*β/se*
σ(Importer) *Reform	0.022	-0.317	-0.033	-0.172	-0.019	-0.091
	(0.03)	(0.22)	(0.02)	(0.11)	(0.02)	(0.13)
Reform	0.421***	0.359***	0.402***	0.387**	0.235*	0.230*
	(0.09)	(0.09)	(0.12)	(0.12)	(0.10)	(0.11)
Constant	9.559***	9.494***	10.714***	10.718***	9.632***	9.749***
	(0.43)	(0.41)	(0.26)	(0.26)	(0.35)	(0.30)
Exporter*Reform	Yes	Yes	Yes	Yes	Yes	Yes
Product FEs	Yes	Yes	Yes	Yes	Yes	Yes
Bilateral FEs	Yes	Yes	Yes	Yes	Yes	Yes
R^2	0.142	0.130	0.144	0.142	0.109	0.112
N	24585	22951	44788	41600	26254	23961

* p<0.05, ** p<0.01, *** p<0.001

Table 1.8. Pooled Panel Estimation

	Full	95 %ile
ln(Imports)	*β/se*	*β/se*
σ(Importer)*Reform	-0.004	-0.265**
	(0.02)	(0.10)
Reform	0.366***	0.329***
	(0.05)	(0.06)
Constant	10.376***	10.241***
	(0.17)	(0.18)
Exporter*Reform	Yes	Yes
Product FEs	Yes	Yes
Bilateral FEs	Yes	Yes
R^2	0.107	0.106
N	210618	199584

* $p<0.05$, ** $p<0.01$, *** $p<0.001$

Chapter 2

U.S. Firm Exports and Intellectual Property Rights

2.1 Introduction

In recent years intellectual property rights (IPRs) have become a highly contentious policy issue, particularly with respect to international trade agreements. At the same time, increasing evidence has shown that the spread of new technologies is a primary determinant of income differences across countries and that international trade can play a role in this diffusion.[1] In this chapter we investigate for the first time how IPR policies affect international trade flows through the extensive margin. We consider two of the central predictions of the model in Chapter I: (i) that a strengthening of IPR policies should expand the range of goods exported to a country and (ii) firms with more recently developed products with fewer substitutes should be more sensitive to IPR policies than other firms due to a higher present value of profits that remain to be realized. Focusing on the manufacturing sector where such issues are the most important, we begin by documenting a number of new stylized facts that explain why IPRs have become such a contentious issue in international trade negotiations; international trade is disproportionately important to innovative firms and these companies account for the overwhelming majority of aggregate exports. We then consider a specification that analyzes the determinants of the destination countries to which firms export. The results are strongly consistent with the two predictions of the model, suggesting that IPR policies are closely related to the exporting decisions of firms. We think that our findings can inform policy debates concerning IPRs and will likely only grow in importance as new technologies become increasingly central to economies worldwide.

[1] See Keller (2004) for an overview of the literature on international technology diffusion and its relation to international income convergence, especially via trade.

Until recently, the literature on intellectual property rights and trade has been mostly theoretical in nature. The empirical literature to date has delivered mixed results on how a strengthening of IPRs affects exports. Ferrantino (1993) finds no significant impact of IPRs on trade, Smith (1999) finds a negative impact, and Maskus and Penubarti (1995) and Ivus (2010) have found positive impacts. The problem facing firms, however, should be different for the different margins of trade, yet this distinction has thus far not been explored in the empirical literature. In policy debates many of the arguments advanced for why IPR policies should affect international trade are often with respect to the extensive margin of trade of whether or not firms export to a particular country, rather than just the aggregate volume of trade. In this chapter, we explore exactly this extensive margin relationship.

As our work is the first to match comprehensive information on patenting behavior with export and production activities at the firm level, we are able to provide the most detailed description to date of the nexus between innovation and trade. Due to data constraints as well as the fact that manufacturing industries account for the vast majority of patents, we focus on this sector for the analysis. We find a powerful relationship between the two activities, with exporters far more likely than other firms to patent as well as to hold a larger number of patents conditional on holding one. Patenting firms are also far more likely to export. Indeed, 82% of firms with patents export to at least one country. Patenting firms also account for 89% of total exports, even though they only account for 9% of all firms.

We next consider cross sectional evidence on the relationship between trade and intellectual property rights policies. Using an index of IPR protection strength across countries, we find that firms with patents are more sensitive to IPR policies than firms without patents. We further find that firms with more recently developed patents are more sensitive to IPRs than firms with older patented technologies. These two findings are strongly consistent with the model of Chapter 1 and suggest that the mechanisms explored in this theory can help explain the composition of trade flows that we observe across countries. These results are robust across a number of different estimation approaches and econometric methods.

Our results speak to a number of issues in policy debates. They are consistent, for example, with the claims of developed country trade representatives that a strengthening of IPRs should provide additional incentives for exports from their countries. Given the importance of patenting firms to aggregate trade, they also help explain why this has been a top priority for US trade negotiators. The findings further have significant implications for welfare in developing countries. IPR reforms should expand the range of goods exported to the country, which should in and of itself improve the welfare of consumers through love of variety effects.

Access to an expanded range of intermediate inputs may also benefit firms in countries that pursue reforms (e.g., Rivera-Batiz and Romer, 1991). This, too, may further increase the range of varieties and types of products ultimately available to consumers, generating dynamic welfare gains. A substantial amount of US exports are of intermediate inputs, and recent studies have highlighted the importance of access to imported intermediates for firm productivity and innovation (e.g., Goldberg, Khandelwal, Pavcnik, and Topalova, 2010). Thus, while the debate about whether stronger IPR policies encourage or hinder innovation is ongoing (e.g., Williams, 2013), our work highlights an indirect channel through which stronger IPR policies can help spur innovation. This is particularly true with respect to the developing country context. Our results should therefore inform not only discussions in trade negotiations but also policy debates within developing countries themselves.

Finally, our results contribute to an understanding of the determinants of cross-country differences in the standard of living. Empirical studies on the growth experiences of recent years as well as the work of economic historians has highlighted the important role of technology diffusion in determining economic development. International trade has long been thought of as a conduit for such diffusion. Our work suggests a subtle relationship between these two activities. Firms are very much aware of the risks involved in exporting to low IPR countries, highlighting that while these policies may determine how likely a technology is to be imitated in the country given that it is sold there, they also determine the range of products actually sold there in the first place. This second mechanism is likely to have dampened the effects of trade as a conduit for technology diffusion across countries.

In the next section we describe our data and a number of descriptive analyses on the relationship between trade and innovation. We then discuss the details of our specification and cross sectional estimations in Section 2.3. We conclude in the last section, discussing future directions for our work that build upon the analyses presented here.

2.2 Data and Descriptive Statistics

2.2.1 Data

Our data come from a number of sources. Information on firms' exports comes from the Census Bureau's Linked/Longitudinal Firm Trade Transaction Database (LFTTD). It links export shipments reported by US Customs to individual firms and allows us to follow these transactions from 1992 to 2008. Data are collected for every export transaction with a value greater than $2,500 and we recode the shipment values below $2500 as zero for the sake of consistency. For each shipment, we have information on the value, destination country, port and a number of other variables. In order to get basic information on firm characteristics, we merge the LFTTD with the Longitudinal Business Database (LBD), which tracks employment, payroll, and industry measures for every legally operating business establishment in the Unites States. These establishments can be aggregated to the level of the firm using identifiers developed by the Census. Jarmin and Miranda (2002) provide a thorough description of the construction of the LBD as well as a number of associated descriptive analyses.

In order to obtain more detailed information on firm characteristics, we combine this merged data set with the Census of Manufacturers (CMF). This survey of all manufacturing establishments in the United States is done every five years, in the years ending in 2 or 7 (e.g. 1997). We only keep firms with positive employment that appear in both the LBD and CMF, drop those for whom we have not been able to assign an SIC code using the LBD data, and then drop those firms who are not determined to be primarily manufacturing firms from the LBD based on employment counts across sectors. While this has the disadvantage of restricting our analysis to manufacturing firms, it allows us to account for a far greater level of firm-level heterogeneity and focuses the analysis on the sectors that matter the most for these issues. For example, Balasubramanian and Sivadasan (2011) document that manufacturing firms account for approximately 70% of all patents. Manufacturing exports also account for a substantial portion of US exports, suggesting that these industries are of primary importance for understanding the effects of intellectual property rights on trade.

Our information on patents come from the US Patent and Trademark Office (USPTO) and covers the universe of granted patents in the US. Hall, Jaffe, and Trajtenberg (2001) describe these records in depth and Griliches (1990) discusses the use of patents as indicators of innovation. We have updated these records to cover the period from 1975 to 2008, containing over 4 million granted patents. These data were then merged with the Longitudinal Business Database using a bridge originally developed by and described in Kerr and Fu (2008), Balasubramanian and Sivadasan (2011), and Acemoglu, Akcigit, Bloom, and Kerr (2013). This bridge was developed by using a matching algorithm between firm names and addresses contained in both the Census data and patent records. We further hand matched a number of the patents for the largest exporting and R&D firms using the LFTTD and the Census's Survey of Industrial Research and Development. We only keep patents with an associated assignee and only keep private sector patents for the analysis. Following standard practice in the literature, we consider the date of a patent to be its application year throughout the various analyses. Based on patent law, a firm's total patent stock is measured by aggregating all of the granted patents that it applied for in the last 20 years.

Our sample of countries is determined by our ability to obtain information on them from outside sources. In order to control for a number of foreign country characteristics, we used information from several additional sources. First, measures of GDP and population were sourced from the World Bank and were complemented with using information from the CIA World Factbook for a few missing observations. From Centre d'Etudes Prospectives et d'Informations Internationales (CEPII), we obtained measures of (i) whether or not the country shares a border with the US (ii) an indicator for whether the country shares a common language with the US, which equals 1 if a language is spoken by at least 9% of the population in both countries (iii) the number of hours in time difference between the US and the country (iv) whether the country shares a colonial relationship with the US (i.e. Britain) and (v) the area of the country in square kilometers. These measures have become standard covariates in the literature on understanding the determinants of trade flows.

Measures of distance from the US are also sourced from CEPII. They are calculated following the great circle formula, which uses the latitudes and longitudes of the most important city in each country in terms of population for the distance from the US. From the data set developed by Helpman, Melitz, and Rubinstein (HMR 2008) we use data on the similarity of the religious makeup of the country with the US, whether the country is an island, and whether it is landlocked. The common religion variable is constructed as in the original study by HMR (2008): (% Protestants in the US · % Protestants in country j)+(% Catholics in the US ·% Catholics in country j) + (% Muslims in the US · % Muslims in country j). This measure has been found to be an important determinant of trade flows, in particular with respect to the extensive margin of trade.

To measure the strength of intellectual property rights protection across countries, we use an index (hereafter the "GP index") originally developed by Ginarte and Park (1997) and updated by Park (2008). This measure was constructed for every five years going back to 1960 and is based on five categories of patent protection (i) the extent of coverage of patent laws, (ii) membership in international patent agreements, (iii) provisions for loss of protection, (iv) enforcement mechanisms, and (v) duration of protection. Each country receives a score between zero and one for each category, with an aggregate possible total score of 5. In Table 2.1 in the Appendix, we list the countries in our sample ranked by their GP index. The ordering makes sense intuitively, with Japan and the countries of Western Europe at the top of the list and countries like Ethiopia and Mozambique towards the bottom.

2.2.2 Descriptive Statistics

In Table 2.2, we report a number of tabulations with respect to innovative and exporting activities. Here, as well as in the estimations in Section 2.3, we focus on the year 1997 in order to take advantage of information on firm characteristics contained in the CMF, which is not otherwise available from other sources. While 24% of firms without patents export, 82% of those with patents export, indicating that the vast majority of innovative firms are connected to the global economy. This result mirrors that of Aw, Roberts, and Xu (2011) for the Taiwanese electronics industry. It also suggests that international trade is a central issue for innovative firms, particularly from a policy perspective. Looking at this relationship from the perspective of trade, 25% of exporters have a patent while only 2% of non-exporters do. In terms of the average number of countries sold to for exporters, we find a significant difference between firms with patents and those without them. Those without patents export to three countries on average while those with patents tend to export to eleven on average. There is significantly more dispersion, however, in the number of countries exported to for firms with patents.

Looking at the relationship between trade and innovation from the other side, amongst firms that have at least one patent, exporting firms have 36 patents on average. Non-exporting firms only have 2 on average. Similar to the previous statistic, there is significantly more variation amongst exporting firms. Considering foreign innovative activity, 9% of firms that have patents hold at least one in which one of the inventors was located abroad. There is also a close association with exporting here as well. Exporters are four times more likely to hold patents as non-exporters. Amongst firms that both hold patents and export, there is a 53% correlation between the total number of patents held by the firm and the total value of foreign export sales.

In Figure 2.1, we look across the firm size distribution at the percentage of exports within each employment decile. For the purposes of disclosure from the Census Bureau, we combine the Food and Tobacco industries together. We find that there exists a positive relationship between firm size and the patent intensity of exports across size categories, and this effect is particularly strong for the top decile of firms. Figure 2.2 similarly shows significant variation in the share of exports that come from patenting firms across industries. The results make sense intuitively, with industries like Lumber and Wood Products (SIC 24) having low patent intensity of exports and those like Electronic and Electrical Equipment (SIC 36) having a high share. We find significant variation across industries in (i) the percentage of patenting firms that export and (ii) the percentage of exporting firms that patent. Both of these measures are significantly and positively correlated across industries with the percentage of exports that come from firms that hold a patent, although they do not track this figure close to one-for-one. We find less variation in this measure across regions of the country, with New England (Census Division 1) with the lowest share at 77% and the area around the Great Lakes (Census Division 3) at 94%.

Figures 2.3 and 2.4 show the average time path of a firm's exports around the time of its very first patent. For this analysis, we identify the year in which a firm first patented and restrict the sample to the 1,744 firms that first patented in our sample period. We consider the five years before the year of first patenting and the four years after, for a total of ten years including the year in which the firm patented for the first time. Our data extend from 1993 to 2006 and as such the analysis considers firms that first patented in the five year window between 1998 and 2002.

Figure 2.3 shows that the average number of annual export transactions of a firm is roughly constant up until the year prior to its first patent application and then begins to rise from there on. Figure 2.4 shows a very similar trajectory for the overall value of exports as well. These results speak to a strong relationship between patenting and firm exports. We find that these trends are primarily driven by the top end of the distribution, however. Median values across firms for these measures tend to increase gradually over time around a firm's first patent, as does the average number of countries to which firms export. We find similar patterns for both mean and median values when limiting the sample to firms with 20 or more employees, firms that exported in each of the ten sample years around their first patent, or both.

2.3 Cross-Sectional Estimation

2.3.1 Specification

In order to get a sense of whether there is a relationship between a firm's holdings of intellectual property and the sensitivity of their export behavior to IPR policies in foreign countries, we consider the following linear probability model:

$$Export_{ic} = \mu_i + \mu_c + \beta \times Pat_i \times GP_c + \gamma X_{ic} + \varepsilon_{ic} \tag{2.1}$$

Here $Export_{ic}$ is an indicator for whether firm i exported to country c. Fixed effects μ_i account for a variety of firm characteristics, such as productivity, size, and total number of patents. The fixed effects μ_c control for country characteristics such as distance to the US, GDP per capita, and whether they share a common language with the US. X_{ic} contains a number of controls that we will discuss briefly. Our main object of interest here is the coefficient β on the interaction term between the indicator for whether firm i holds a patent Pat_i and GP_c, the GP index of IPR protection for country c normalized to lie between zero and one. If β is estimated to be different than zero, this would suggest that there is a relationship between a firm's dependence on the patent system and its decisions of where to export, in terms of the IPR policies of the countries under consideration.

2.3.2 Results

In column (1) of Table 2.3 we consider a specification with our basic set of controls. All estimations cluster standard errors at the level of the firm. In addition to our main interaction term we include interactions between (i) whether or not a firm had a patent and the GDP per capita of the country, (ii) the log employment of the firm and the GP index of the country, and (iii) the productivity of the firm and the GP index of the country, where productivity is measured with the Solow residual. The first interaction is to control for potential differing firm export behavior to destination markets of different sizes based on their patenting status, e.g. if patenting firms are more likely to export to wealthier markets. The second interaction term controls for potential exporting differences to countries with differing IPR protection based on the size of the firm, e.g. if larger firms are more likely to export to strong IPR destinations. The final interaction term accounts for potential export variation to destinations with different IPR levels based on firm productivity levels, e.g., if more productive firms are more likely to export to destinations associated with stronger IPRs.

The estimate $\hat{\beta}$ suggests that an improvement of the destination market GP index from the lowest to the highest possible value is associated with a 5% increase in the probability that a firm with a patent exports to the country, relative to a firm without patents, ceteris paribus. Thus, if a country improved its level of IPR protection from that in Angola to that of the United Kingdom, for example, this would be associated with a 3.8% increase in the probability of a firm exporting to said country. This relationship is very precisely estimated, with a t statistic of 37. The size of this relationship is also economically significant; as a benchmark for comparison, the unconditional probability that a firm exports to one of the countries in our sample is 1.3 percent. Positive and statistically significant coefficients on the other interaction terms imply that (i) bigger firms (measured by employment) are more likely to export to higher IPR markets, (ii) higher productivity firms are more likely to export to stronger IPR destinations and (iii) patenting firms are more likely to export to wealthier destination markets.

In column (2) we consider how the relationship between IPR strength and the likelihood to export varies across different levels of IPR protection, allowing for the possibility that the relationship may be non-linear. We define high IPR protection countries as those with GP scores between 4 and 5 and those with medium IPR protection strength as those between 3 and 4. We then consider a specification in which we include interactions between these indicators and our patent indicator. Effects are measured relative to countries with GP indices below 3. We find positive, statistically significant coefficients for each of the interaction terms, with economically intuitive magnitude differences across the two different interaction terms. The results indicate that a patenting firm is more likely to export to both a mid-range and a high-range GP index destination than a low GP destination (by 2.6% and 7.1%, respectively) and that the firm is even more likely to export to a high index country than a medium index country. This suggests that the relationship between patent and IPR levels is indeed non-linear, but non-linear in the same direction, so that usage of a linear approximation is not necessarily problematic.

In specification (3) we additionally include a whole bevy of additional controls into our baseline specification in column (1). In particular, we interact our patent indicator Pat_i with a number of different country characteristics, including (i) distance from the US, measured in kilometers, (ii) whether or not the country shares a border with the US, (iii) whether or not the country shares a common language with the US, defined as described above, (iv) the geographic area of the country in square kilometers, (v) the number of hours in time difference between the US and the country, and (vi) whether the country shares a colonial relationship with the US (i.e. Britain). When adding these controls, the coefficient estimate $\hat{\beta}$ declines modestly but remains economically and statically significant. The estimations in columns (1)-(3) are all consistent with the central prediction of the model of Chapter 2, that IPR policies should be related to the range of products exported to a country through the extensive margin of trade.

In the final two columns, we consider one of the other main predictions of the model in Chapter 2, that firms with more newly developed patents, and hence more inelastically demanded products, should be more sensitive to IPR policies than other firms due to a greater discounted value of expected future profits. To do so, we consider two specifications similar to those found in columns (1) and (3). We additionally include an interaction term between (i) whether or not a firm has a patent, (ii) the GP index for the country, and (iii) the average age of a firm's patents. Consistent with the predictions of the model, the negative and significant coefficient on this triple interaction term suggests that firms with more recently developed products tend to be more sensitive to IPR policies with respect to their exports. As the average age of a firm's patents is 7 years, however, these results suggest that the age of a firm's patents is not the only factor affecting this relationship. Across columns (4)-(5), the coefficients on the other independent variables remain similar to those in their counterparts in columns (1) and (3).

We have done a number of robustness checks on these results. Getting to the role of market size in the model, the regression results are robust to including a measure of total GDP instead of GDP per capita. Another issue is that considering the binary indicator Pat_i for whether the firm has a patent or not may be too strong of a categorization. Using a measure of the total number of the firm's patents in the interaction terms also yields statistically significant effects. Finally, while the results presented here use a linear probability model, we further come to similar conclusions using the conditional fixed effects logit model of Chamberlain (1980).

2.4 Conclusion

In this chapter we study how IPR protections in foreign countries affect exports to those countries through ther extensive margin. We begin by documenting a number of new stylized facts that suggest the importance of the relationship between trade and innovation. Drawing upon the model in Chapter 2, we then considered two of its central predictions (i) that IPR policies should affect the extensive margin of trade and (ii) that firms with more recently developed patents should be more sensitive to IPR policies than other firms. We find evidence consistent with both of these claims that is robust to a number of different estimation approaches.

Our results shed light on a poorly understood mechanism by which innovation policies affect international trade. These effects are likely to impact welfare not only through changes to the number of varieties of goods available to consumers but also through the range and quality of imported intermediate goods that firms can use in production. To the extent that trade affects the diffusion of ideas, our results also suggest that reduced trade due to poor intellectual property rights protection is likely to dampen the rate of adoption of new foreign technologies. This is important for issues of economic development, as innovation in the US, Japan, and Germany has been found to drive a significant portion in the growth in foreign countries (Eaton and Kortum 1996, see also Coe and Helpman 1995). Given the rise of computer technology and growth in patented innovations in recent years, we think these issues are only likely to grow in importance. We hope that future research continues in this vein.

2.5 Appendix

Table 2.1: Intellectual Property Rights Indices of Countries in Our Sample

Rank	Country	GP	Rank	Country	GP	Rank	Country	GP	Rank	Country	GP
1	Belgium	4.54	31	Taiwan	3.17	61	Tanzania	2.32	91	Chad	1.78
2	Denmark	4.54	32	Israel	3.14	62	Zimbabwe	2.28	92	Niger	1.78
3	France	4.54	33	Mexico	3.14	63	Fiji	2.20	93	Egypt	1.73
4	Netherlands	4.54	34	Sri Lanka	2.98	64	China	2.12	94	Tunisia	1.65
5	United Kingdom	4.54	35	Czech Republic	2.96	65	Iraq	2.12	95	Zambia	1.62
6	Finland	4.42	36	Slovak Republic	2.96	66	Liberia	2.11	96	Malta	1.60
7	Japan	4.42	37	Hong Kong	2.90	67	Cameroon	2.10	97	Costa Rica	1.56
8	Sweden	4.42	38	Vietnam	2.90	68	Gabon	2.10	98	Indonesia	1.56
9	Canada	4.34	39	Jamaica	2.86	69	Uruguay	2.07	99	Paraguay	1.53
10	Italy	4.33	40	Nigeria	2.86	70	Ecuador	2.04	100	Brazil	1.48
11	Austria	4.21	41	Uganda	2.85	71	Malawi	2.03	101	Panama	1.46
12	Spain	4.21	42	Ghana	2.83	72	Somalia	2.00	102	Pakistan	1.38
13	Switzerland	4.21	43	Venezuela	2.82	73	Burkina Faso	1.98	103	India	1.23
14	Australia	4.17	44	Cyprus	2.78	74	C. African Republic	1.98	104	Guyana	1.13
15	Germany	4.17	45	Algeria	2.74	75	Mali	1.98	105	Nicaragua	1.12
16	Ireland	4.14	46	Colombia	2.74	76	Mauritania	1.98	106	Guatemala	1.08
17	Hungary	4.04	47	Argentina	2.73	77	Senegal	1.98	107	Jordan	1.08
18	New Zealand	4.01	48	Peru	2.73	78	Togo	1.98	108	Angola	0.88
19	Chile	3.91	49	Malaysia	2.70	79	Rwanda	1.95	109	Burma	0.20
20	South Korea	3.89	50	Lithuania	2.69	80	Mauritius	1.93	110	Ethiopia	0.00
21	Norway	3.88	51	Iceland	2.68	81	Iran	1.91	111	Mozambique	0.00
22	Singapore	3.88	52	Turkey	2.65	82	Congo	1.90	112	Papua New Guinea	0.00
23	Ukraine	3.68	53	Sudan	2.61	83	Honduras	1.90			
24	Russian Federation	3.48	54	Haiti	2.58	84	Ivory Coast	1.90			
25	Greece	3.47	55	Philippines	2.56	85	Bangladesh	1.87			
26	Poland	3.46	56	Sierra Leone	2.45	86	Syria	1.87			
27	South Africa	3.39	57	Kenya	2.43	87	Madagascar	1.85			
28	Portugal	3.35	58	Thailand	2.41	88	Saudi Arabia	1.83			
29	Bulgaria	3.23	59	Bolivia	2.37	89	Nepal	1.79			
30	El Salvador	3.23	60	Trinidad & Tobago	2.33	90	Benin	1.78			

Notes: Table rank the 112 countries in our sample based on their index of intellectual property rights in 2005 as developed by Ginarte and Park (1997) and updated by Park (2008). This index is constructed based on five categories of patent protection discussed in the text.

Table 2.2: Descriptive Statistics for Firm Panel

	Mean	Standard Deviation
Total exports accounted for by firms with patents	89%	
Firms that export (%)	29%	
Firms that export, amongst patentors	82%	
Firms that export, amongst non-patentors	24%	
Firms that have a patent (%)	9%	
Firms with patent, amongst Exporters	25%	
Firms with patent, amongst Non-Exporters	2%	
Firms with a foreign patent, amongst patentors	91%	
Average number of patents		
Amongst patenting firms	30	368
Amongst patenting firms that export	36	406
Amongst patenting firms that do not export	2	6
Average number of countries exported to	5	8
Amongst exporters		
Amongst patenting firms that export	11	13
Amongst non-patenting firms that export	3	5

Notes: Table describes a number of tabulations on exporting and innovative activities for manufacturing firms in the US. These are based on the 158,234 firms in the sample described in Section 2 of the paper.

Figure 2.1: Percentage Exports Accounted For by Patenting Firms Across the Firm Size Distribution

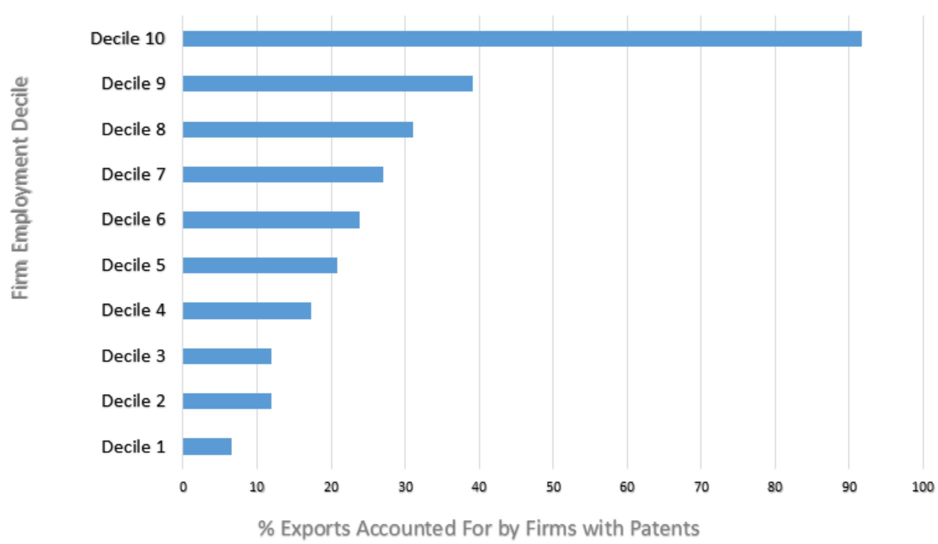


Figure 2.2: Proportion of Exporting Firms With a Patent Across Industries

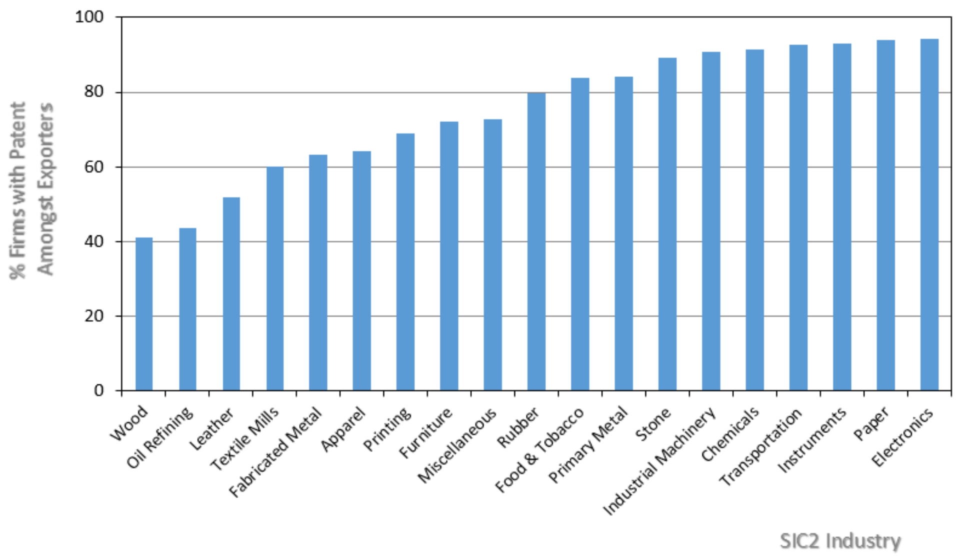
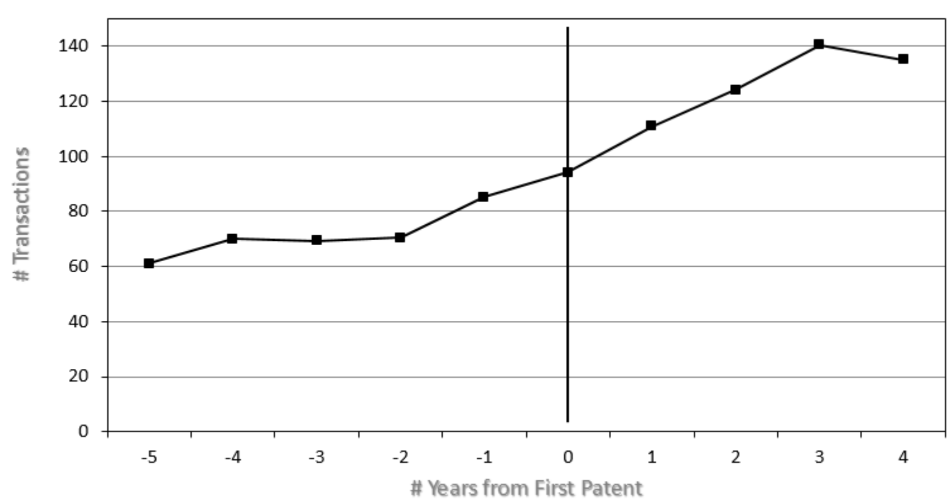


Figure 2.3: Average Number of Annual Export Transactions Circa a Firm's First Patent



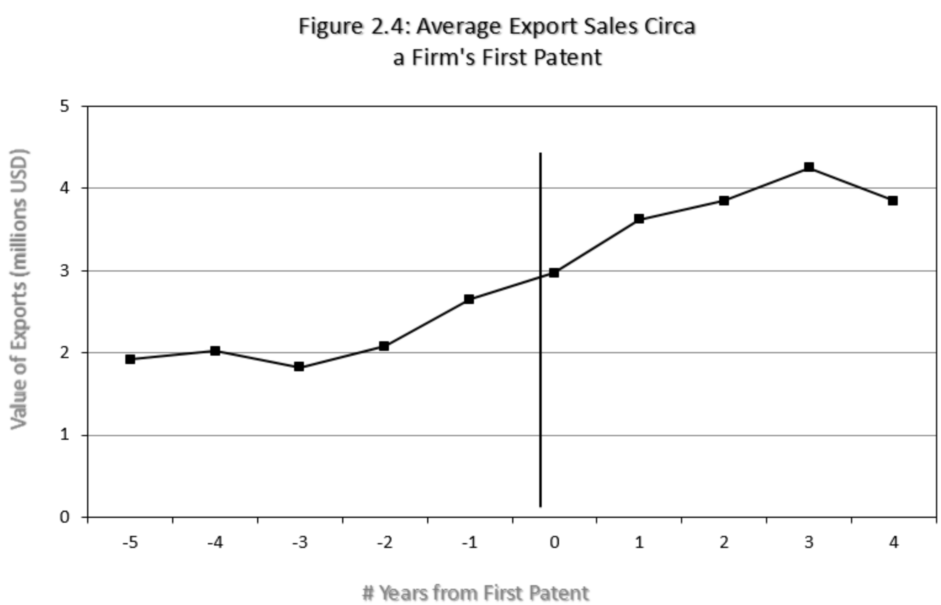


Figure 2.4: Average Export Sales Circa
a Firm's First Patent
Value of Exports (millions USD)
0
1
2
3
4
5
-5
-4
-3
-2
-1
0
1
2
3
4
Years from First Patent

Table 2.3: Determinants of Exporting

Dependent: (0,1) indicator for whether firm exports to a country	(1)	(2)	(3)	(4)	(5)
(0,1) Patent * GP index	0.05144***		0.03629***	0.06619***	0.05103***
	(0.0015)		(0.0014)	(0.0037)	(0.0036)
(0,1) Patent * GP index * Average Patent Age				-0.0022***	-0.0022***
				(0.0005)	(0.0005)
(0,1) Patent * (0,1) Medium GP index		0.0262***			
		(0.0007)			
(0,1) Patent * (0,1) High GP index		0.0706***			
		(0.0012)			
Log(employment) * GP index	0.0365***	0.0071***	0.0365***	0.0366***	0.0366***
	(0.0004)	(0.0001)	(0.0004)	(0.0004)	(0.0004)
Productivity * GP Index	0.0160***	0.0031***	0.0160***	0.0159***	0.0159***
	(0.0005)	(0.0001)	(0.0005)	(0.0005)	(0.0005)
(0,1) Patent * Log(GDP per capita)	0.0281***	0.0220***	0.0304***	0.0281***	0.0304***
	(0.0004)	(0.0003)	(0.0004)	(0.0004)	(0.0004)
(0,1) Patent * Log(Distance)			0.0371***		0.0371***
			(0.0011)		(0.0011)
(0,1) Patent * (0,1) Shares Border			0.2365***		0.2365***
			(0.0028)		(0.0028)
(0,1) Patent * (0,1) Common Language			0.0108***		0.0108***
			(0.0004)		(0.0004)
(0,1) Patent * Area			0.0000		0.0000
			(0.0000)		(0.0000)
(0,1) Patent * Time Difference			-0.0056***		-0.0056***
			(0.0002)		(0.0002)
(0,1) Patent * (0,1) Colonial Relationship			0.0997***		0.0997***
			(0.0016)		(0.0016)
(0,1) Patent * Common Religion			-0.0779***		-0.0779***
			(0.0014)		(0.0014)
(0,1) Patent * (0,1) Island			-0.0176***		-0.0176***
			(0.0007)		(0.0007)
(0,1) Patent * (0,1) Landlocked			-0.0102***		-0.0102***
			(0.0004)		(0.0004)
Firm Fixed Effects	Yes	Yes	Yes	Yes	Yes
Country Fixed Effects	Yes	Yes	Yes	Yes	Yes

Notes: Estimations consider the determinants of exporting to a particular country. All specifications include country and firm fixed effects and cluster standard errors at the level of the firm. There are 158,234 firms in the sample and we consider the determinants of their export behavior to a set of 112 countries, for a total number of observations of 17,722,208. These countries are listed in Table3.

* denotes statistical significance at the 1-5% level
** denotes statistical significance at the 0-1% level

Chapter 3

Financial Inclusion and Stability in Africa's Middle-Income Countries

3.1 Introduction

Over recent years, financial inclusion/access to finance has become increasingly important to authorities in countries seeking to advance in the development process in a socially equitable manner[1]. Financial access is often framed within the context of financial deepening and overall financial development. Research has shown that the positive correlation between financial development and growth is highly robust (Levine and Zervos 1993). Thus it is particularly important to study whether developing countries hoping to spur economic growth would either spur or jeopardize financial development by promoting increased financial access across the population.

Financial stability and financial inclusion are often considered to be conflicting goals. For example, financial stability focuses on asset quality. This means that banks need to be more selective in terms of to whom they lend and provide financial services. In contrast, financial inclusion focuses on quantity such as size of assets and the number of customers. This often means that financial institutions might lower their standards for lending and reduce the minimum balance requirement or fees associated with opening or maintaining a bank account. A natural question is then whether greater financial inclusion might reduce financial stability, although if financial inclusion raises growth, it could also have a positive impact on banks' asset quality and profitability. Another question is whether different types

[1] Mohan (2006) details these financial inclusion measures in the case of India: "not only is financial inclusion essential because of its implications for the welfare of citizens but it needs to be stressed that it has to be an explicit strategy for fostering faster economic growth in a more inclusive fashion... to place the strategy of financial inclusion in the wider context of economic growth and financial deepening."

of financial inclusion might affect financial stability in different ways. Third, the current global regulatory reforms will likely encourage banks' funding structures to shift towards greater holdings of equity and deposits. The paper will verify whether this funding structure shift will strengthen financial stability.

In this paper, we address each of the above issues, by exploring the following questions: How has the financial landscape in SSA MICs evolved? How does the financial landscape (stability and inclusion) in SSA MICs compare relative to emerging market economies (EMs)? How do financial inclusion and funding structure shifts impact financial stability? Does the particular type of financial access matter? We utilize a novel econometric application of binary response models to explore the intersection of these two branches of research and analyze whether stability and access can coexist in tandem in an attempt to fill the gap in quantifying whether a relationship exists between stability and access, what the relationship is and what channels it operates through.

We analyze financial stability at the bank level in Middle-Income Countries in Sub-Saharan Africa (SSA MICs). Our sample covers 227 banks in the 11 SSA MICs, spanning up to 15 years, from 1998-2013. We conduct a joint bank-level stress test determining the probability of bank default stemming from standard causal factors, additionally including various inclusion indicators as explanatory variables. We measure financial access utilizing the following country-level individual and small- and medium-enterprise (SME) access indicators from the World Bank Financial Access Survey and Enterprise Survey: percentage of adults saving to total adults, percentage of adults borrowing to total adults, percentage of SMEs identifying access to finance as a major business constraint and small firms with access to a credit line as a percentage of total small firms. The use of a variety of access indicators serves both the function of a robustness check of indicator validity as well as a means by which we can differentiate between effects of different types of financial inclusion.

Our findings suggest the following: (i) financial stability and financial inclusion for individuals in SSA are comparable to a group of EMs[2] while financial inclusion for small and medium enterprises (SMEs) lags behind EMs; (ii) financial inclusion focusing on expanding SMEs access to finance and individuals' access to savings accounts enhances financial stability while financial inclusion focusing purely on expanding the percentage of individuals with credit undermines financial stability; and (iii) a more equity and deposit based funding structure enhances financial stability.

The paper is organized as follows. Section 3.1.1 reviews the literature. Section 3.2 reviews the evolution of the overall financial landscape and of financial inclusion in the 11 SSA MICs

[2]The group of emerging market economies is selected based on the April 2012 IMF Regional Economic Outlook for Africa, peer countries to South Africa. The EM countries are listed below in page 7.

in comparison with a group of selected EMs, Section 3.3 analyzes the impact of financial inclusion and banks' funding structure on financial stability. Section 3.4 discusses policy measures to promote financial inclusion while enhancing stability.

3.1.1 Literature Review

Much work has been done on financial sector stability and a growing body of the literature is focusing on financial access as well. The literature on financial inclusion/access primarily focuses on exploring the effects of individuals' access on income inequality, poverty, and GDP growth. For example, The Global Financial Index (Findex) surveys "how adults in 148 economies save, borrow, make payments, and manage risk" and finds that high cost, physical distance, and lack of proper documentation are the most common barriers to individual access (WB GFDR 2013, Demirgüç-Kunt & Klapper 2012). Additionally, Demirgüç-Kunt, Beck, and Honohan (2008) illustrate that financial access is quite limited around the world and identify barriers that may be preventing small firms and poor households from using financial services. Based on this research, the report derives principles for effective government policy on broadening access. Beck, Demirgüç-Kunt, and Maksimovic (2003) explore the effects of firm-level financial access and find that financial constraints are strongest for small firms and weakening these constraints disproportionately benefits smaller firms.

The literature on financial stability is vast and diverse. Most of the literature has focused on measures and indicators for financial stability (FSIs). Demirgüç-Kunt and Detragiache (1998), Kaminsky, et al (1998), Bordo and Schwartz (2000) pioneered early warning indicators on macro-financial stability based on risk spreads, market liquidity, etc.

Work has also been done to look at predictors of banking crises. Demirgüç-Kunt and Detragiache (1997) use a multivariate logit estimation to identify determinants of banking crises in a panel of developing and industrialized countries. They found that weak macroeconomic environments with low growth, high inflation, high real interest rates, explicit deposit insurance schemes and weak law enforcement were particularly vulnerable to economy-wide banking crises. Demirgüç-Kunt and Detragiache (2005) survey the literature on crisis prediction and identify two main methodologies of the cross-country empirical work in this field based on the signal approach and the multivariate probability model.

Other threads of the literature on financial stability look at: the role of central banks in promoting and maintaining financial sector stability (Nier 2009), bank competition and stability (Berger et al. 2009), financial liberalization and crisis (Caprio and Summers 1993), external shocks and crisis (Eichengreen and Rose 1998), bank ownership and structure as they relate to crisis (La Porta, Lopez-de-Silanes, and Shleifer 2002) and the role of institutions and of the political system in causing and preventing crises (Beck, Demirgüç-Kunt, and Levine 2004).

The literature on the intersection between financial stability and access has, however, been underexplored. Hannig and Jansen (2010) perform a largely qualitative study regarding the risks and benefits of inclusion and find that financial inclusion can pose risks in terms of overall financial sector reputation and quality, but that low-income savers and borrowers maintain "solid financial behaviour" though crises periods and that the presence of "vulnerable clients" in the financial system has negligible risks. They show a positive correlation between GDP per capita and inclusion, but stop short of establishing a causal relationship. Similarly, Khan (2011) shows a positive relationship between financial inclusion, as measured in terms of commercial bank branches per 100,000 adults and deposits per 1000 adults, and development as measured by World Bank Development country categories (High Income, Low Income, etc.). This, however, is based purely on graphical correlation. Aduda and Kalunda (2012) explore financial inclusion and stability with reference to Kenya and postulate that "it is very likely that banking performance, and the likelihood of crises, may depend on the structure and degree of development of the financial systems which is one of the focal point [sic] in financial inclusion." However, there is no quantitative analysis.

This paper addresses a different question from previous work and provides the first quantitative evidence that we know of on the impact of financial inclusion and shifts in funding structure on stability. Rather than focusing on a qualitative or descriptive assessment based on correlations, we attempt to establish quantitatively whether a causal link exists between financial inclusion, funding structure and stability. We also look at whether and which types of financial inclusion exist that are stability friendly. This analysis focuses on bank-level stability. This approach is taken in the context of SSA for several reasons. First, the banking sector in SSA is relatively small; with 227 banks in the sample, financial inclusion is very important for these countries. Second, financial access levels can have differing impacts on heterogeneous banks and a bank-level analysis can account for fundamental differences between individual banks that may be affecting stability, better isolating the effect of each individual explanatory variable without use of aggregation and its resulting distortions.

3.2 Financial Landscape in Sub-Saharan African Middle-Income Countries

3.2.1 Data

The dataset includes bank-level data for 227 banks in SSA over the period 1998-2013. There are 11 SSA MIC countries covered: Botswana, Cape Verde, Ghana, Lesotho, Mauritius, Namibia, Senegal, Seychelles, South Africa, Swaziland, and Zambia. These countries are the only middle-income countries in Sub-Saharan Africa as officially classified by the IMF and World Bank. Country-level financial stability and access data for a group of EM countries are also included for 2011 for benchmarking purposes. The EM countries are: Argentina, Brazil, Chile, China, Colombia, Hungary, Indonesia, India, Republic of Korea, Mexico, Malaysia, Peru, Philippines, Poland, Romania, Russia Federation, Thailand, Turkey and Ukraine. These countries were chosen based on the peer group, in terms of population and GDP, of South Africa from the IMF Regional Economic Outlook 2012.

Figure 3.4 shows the distribution of bank Z-scores for our sample, with the red vertical line demarcating the 10th percentile cut-off later used in our Probit analysis (more details to follow). The figure shows a substantial variation of Z-scores across our sample of 227 banks. Figure 3.5 shows the distribution of bank-level ln(Z-scores) across the 11 countries of our sample, demonstrating that variation hardly exists at the country-level, lending credence to our bank-level analysis, controlling for bank-level variables.

3.2.2 Evolution

Looking at the financial landscape of the 11 SSA MIC countries over time, we focus on a number of key variables: bank private credit to GDP, overall financial system deposits to GDP, return on assets (ROA), return on equity (ROE), and banking sector Z-score (defined as [(Equity/Assets)+ROA]/SD(ROA)), which is a measure of default risk. Figure 3.1 shows area graphs of the key variables, with the mean in orange, median in green and the range of the statistics across the 11 sample countries shaded in gray.

First, looking at bank private credit to GDP (%) in Figure 3.1, Panel 1, SSA MICs appear to be experiencing overall growth in this area over the past decade, suggesting financial deepening is taking place. The sample average lies at about 36.3% in the most recent available year, 2011.

Financial system deposits to GDP (%), shown in Figure 3.1, Panel 2, also appear on the rise for most SSA MICs with the most notable exception of Botswana and some recent loss in growth in Seychelles. The group average rose to 46.5%, up from 37.9% in 1999.

Overall ROA (%), Figure 3.1, Panel 3, a measure of banking sector profitability, appears to be stabilizing at around 2% on average across the sample, which, although down from 2.36% at the beginning of the sample period, is robust.

The banking sector Z-score, Figure 3.1, Panel 4, a popular measure of financial stability, remains stable over the period, although there are notable decreases on this front stemming from Mauritius, Namibia and South Africa. The average Z-score has fallen from 17.52 to 14.91, primarily due to deterioration in the aforementioned three countries. However, overall stability in the region appears to be converging at around 12.3 with Senegal as the group leader with a Z-score of 38.42.

3.2.3 Benchmarking

Financial Stability

We compare our group of 11 SSA MIC countries to the non-SSA EM group of 20 countries for the most recent year for which all data is available, 2011.

In terms of bank capital to assets (%), Figure 3.2, Panel 1, the MICs fare slightly better compared to the EM group with an average capital to asset ratio of 10.3% versus just 10% across EMs. This is driven primarily by the exceptionally high capital to asset ratio of South Africa and, to a lesser extent, Ghana.

Banking sector concentration, measured as the percentage of banking sector assets held by the top 3 banks (Figure 3.2, Panel 2), remains high for the SSA MICs at 79.5% relative to the EMs' average of 51.1%. This is true even for each country individually relative to the EMs and is fairly characteristic of the African banking sector as a whole. This could indicate continued financial sector vulnerabilities due to substantial presence of systemically important financial institutions (SIFIs).

The ROA (%), Figure 3.2, Panel 3, for SSA MICs averages 2%, compared to 1.2% for the EM group. The higher returns appear to be across the board for almost all SSA MICs, however is particularly notable in Botswana. This could be suggestive of potentially more lucrative investment return opportunities in the rapidly growing region or it may be due to the effect of a more concentrated banking sector relative to the EMs.

However, the banking Z-score indicator of stability in Figure 3.2, Panel 4 shows slightly more financial stability in SSA MICs compared to EMs, with an average Z-score of 14.9 versus 13.4. This suggests that, despite potential vulnerabilities stemming from high concentration, the banking sector retains reasonable levels of capital to cover potential losses in equity. This is likely driven by the relatively higher asset returns in SSA MICs, potentially due to greater bank concentration coupled with a general stabilization of the volatility on those returns.

Financial Access

We also compare the 11 SSA MICs to the EM group, in 2011, in terms of access to finance, both at the individual and at the small-medium enterprise (SME) level. The indicators used are: percentage of adults saving, percentage of adults borrowing, percentage of SMEs reporting facing a financial access constraint, percentage of firms with a credit line and percentage of small firms with a credit line.

In terms of percentage of adults saving, which can be thought of as an indicator of individual saving rate SSA MICs average 15.8% versus 16.5% for the EM group, suggesting that access to saving accounts between SSA MICs and the selected EM group is comparable. In addition, the difference is largely driven by the EM outliers Rep. of Korea and Thailand.

With respect to percentage of adults borrowing, the average for SSA MICs stands at 7.33% compared with a 9.58% average for the EM countries. This is despite the relatively high percentage observed in Mauritius. Fewer individuals in the SSA middle-income region appear to have the option of financial access in the form of borrowing.

The percentage of SMEs reporting facing a financial access constraint (based on the Enterprise Survey) averages 33.94% for SSA MICs compared to 23.6% in the comparison group. This difference is consistent even on an individual country basis, with individual SSA MIC countries reporting higher numbers for this statistic than individual EMs. Among these, Ghana faces the highest reported access constraints. This implies that financial constraints facing SMEs in SSA middle-income countries may be more common relative to EMs.

In terms of the percentage of small firms with a credit line, SSA MICs also fare worse compared to EMs with 24% of small firms having access to a line of credit, as compared to 37.8% for the EM group. This points to the fact that access to credit appears far less prevalent for firms in the SSA MICs relative to EMs and is consistent with other SME access survey indicators.

3.3 Empirical Analysis

The framework centers around two econometric models of the determinants of stability. The first is a baseline Probit model with the probability of bank distress as the dependent variable. The second is a standard OLS estimation with percentage deviation, or distance, from bank insolvency as the dependent variable. The use of the distance to insolvency, or Z-score, as a measure of financial stability has substantial precedence in the finance literature[3].

[3]See Altman 2000 for a thorough treatment of the use of Z-scores in predicting financial distress.

3.3.1 Baseline Probit Model

In this section, we explore the effects of financial access on financial stability and, particularly, whether individual or SME financial access affects distress probability differently. Traditional measures of bank distress in the literature include the book-price ratio, analyst ratings and the Z-score. We focus on the Z-score measure of bank distress as it has become the most frequently used indicator, in addition to having greater data availability.The Z-score measure of bank stability is computed at the level of the bank and equals the return on assets (ROA) plus the capital asset ratio (CAR) of the bank divided by the bank's standard deviation of return on assets. It proxies for the risk of bank insolvency as it is the inverse of the probability that losses exceed equity; that is, a higher Z-score implies lower risk of insolvency (see Box 1 for derivation details).

The traditional factors affecting bank distress can be grouped as: (1) funding structure indicators (e.g. Herfindahl funding diversity index, the ratio of loans to customer deposits, the ratio of short-term funding to assets, the ratio of equity to assets, the ratio of term deposits to assets), (2) profitability and asset quality (return on average assets, return on average equity, the ratio of loan loss provisions to gross loans and net interest margin), (3) Size (total assets, asset growth) , (4) macroeconomic factors (e.g. inflation, output growth), and financial access variables (e.g., individual and SMEs access to finance at the country level). Thus, in tackling our question, we must control for the effects of these other factors.

We proceed first by estimating a Probit model of probability of financial distress:

$$P\left\{Distress_{ijt} \mid X_{ijt-1}, W_{jt}\right\} = F\left(X_{ijt-1}\beta_{ij} + W_{jt}\beta_{j}\right) \tag{3.1}$$

where $P\{\}$ is the probability that bank y_i from country j will be in distress at time t, conditional on bank-specific and country-level characteristics X_{ijt-1} and W_{jt}. $P\{\}$ is based on the Z-score and is a decreasing function of the Z-score. $F()$ is the standard normal distribution function that transforms a linear combination of the explanatory variables into the $[0, 1]$ interval.

$Distress_{ijt}$ is measured by bank-level Z-scores, with a threshold at the 10th percentile of Z-scores within the sample[4], which is equivalent to being above the 10th percentile in probability of default (see Box 1 in Appendix). The presence of bank-specific lagged explanatory variables, X_{ijt-1}, is primarily to reduce endogeneity concerns and report robust standard errors, but also to control for bank-level characteristics (e.g. size) that may make

[4]The 10th percentile threshold was chosen in line with that of a recent estimation in Global Financial Stability Report October 2013 utilizing a similar model of probability of bank default. In that estimation, the 10th percentile of bank Z-scores for that sample was chosen.

an individual bank particularly sensitive or insensitive to country-wide macroeconomic conditions. Finally, country-specific explanatory variables, W_{jt}, must also be included to control for macroeconomic conditions that can obviously impact a given bank's default probability.

The explanatory variables used are summed up in the following table, with more detailed descriptions given in Table 3.2 of the Appendix.

Bank-level Variables, X_{ijt}	**Country-level Variables, W_{jt}**
Funding structure	*Access/financial inclusion*
• Herfindahl index of funding diversity	• Percent of adults saving
• Loans to customer deposits ratio	• Percent of adults borrowing
• ST funding to assets ratio	• Percent of SMEs identifying access to finance as a major constraint
• Term deposits to assets	• Percent of small firms with a credit line
Profitability and asset quality	
• Return on Average Equity	*Macro and financial variables*
• Loan loss provisions to gross loans	• GDP per capita
• Net interest margin	• GDP Growth
	• GDP Growth-Bank Size interaction
Size	• Interest rate spread
• Total Assets	• Inflation, GDP deflator
• Asset growth	• Banking regulatory quality and disclosure
	• Volatility of stock price index, 360-day SD
	• Human Development Indicator

3.3.2 Baseline Logarithmic Model

We attempt to look at the relationship in levels and ensure that our Probit results are not sensitive to the choice of binary cutoff threshold by looking at the impact of explanatory variables on the percentage change in Z-score, that is, ln (Z-score).

We estimate a standard linear regression of ln (Z-score) on bank-level explanatory variables, X_{ijt-1}, and macro-level stability variables, W_{jt}:

$$\ln(\text{Z-score}) = F\left(X_{ijt-1}\beta_{ij} + W_{jt}\beta_j\right) \quad (3.2)$$

In order to include observations corresponding to negative values of the Z-score, which cannot be log-transformed, we adjust additively relative to the minimum Z-score using ln (Z-score+min(Z-score)+1) in order to keep all observations under the previous binary dependent variable estimation in this analysis as well. All other explanatory variables are kept the same and given in the following table. The estimation again uses lagged bank-level explanatory variables in order to reduce endogeneity concerns and report robust standard errors.

3.3.3 Dependent Variables

Probit

$P\{Z<10\text{th percentile}\}$ is a binary dependent variable representing the probability that a bank's Z-score is below the 10th percentile of Z-scores of regional banks, putting it at risk of default relative to other banks in the sample. As the Z-score represents the adequacy of a bank's capital to cover potential equity losses and thus is directly and inversely related to the probability of default, higher values of the Z-score correspond to greater solvency. This cutoff is equivalent to the probability of a bank experiencing a default being amongst the top 10 percentile of sample banks (see Box 3.2 in Appendix for proof). Thus positive coefficients on explanatory variables would indicate a negative contribution of that variable towards bank-level stability. The 10th percentile is chosen as a measure in line with the convention in related literature (c.f. IMF Global Financial Stability Report, October 2013); other nearby cutoffs were tested for robustness with very similar results.

ln(Z-score)

ln (Z-score) is a continuous dependent variable representing the percentage increase relative to the lowest bank Z-score present in the sample. Under this dependent variable, positive coefficients on explanatory variables correspond to greater solvency and a decreased probability of bank default. This variable is auxiliary in our analysis due to the fact that the true relationship between explanatory variables and bank stability is likely piece-wise linear. Thus, beyond a certain point of high values of Z-score, observed explanatory variables may have increasingly weak marginal impacts on stability and unobserved variables may carry more weight; this can appear in an estimation as a weakening of the causal link between independent variables and dependable variable (financial stability).

In order to account for potential non-linear relationships between explanatory variables and ln(Z-score), we performed local polynomial smoothing analysis of all variables and found that non-linear relationships existed for variables Total Assets and the ratio of Short-term Funding to Assets. We adjust for these non-linear relationships by including splines for these two non-linear variables in the estimation. Figures 3.6 and 3.7 in the Appendix show the local polynomial smoothing graphs and demonstrate the kinks in the series that represent the spline cut-offs (detailed in the variable explanation section of the Appendix).

3.3.4 Independent Variables

The independent variables are explained in detail in the Appendix.

3.4 Empirical Findings

In general, we find that higher equity to assets, term deposits to assets, and percentage of adults saving lead to increased stability. We also find that higher ratios of loans to customer deposits, percentage of adults borrowing, percentage of SMEs facing financial access constraints and less diverse funding sources lead to increased probability of banking sector distress.

The Probit estimations are conducted using the two measures of SME access separately, due to collinearity issues, although results with either measure of SME access are similar. Under SME Access Constraint as reported in the World Bank Enterprise Survey, individual bank size, term deposits to assets, equity to assets, country legal index and both individual access as well as SME access variables are significant determinants for bank-level stability. The signs of these coefficients give a sense of their contribution to financial stability. Recall that in the Probit analysis, our dependent variable is a measure of likelihood of bank distress, that is, the inverse of financial stability. Bank size, measured as total assets, has a positive and highly significant effect on the probability of distress. The proportion of assets that are term deposits increases stability significantly.

Negative coefficients indicate that the variable is associated with greater bank stability while positive coefficients indicate the variable is associated with greater bank distress. Tables 3.6-3.10 present our empirical findings. Tables 3.6 and 3.7 present the baseline Probit estimation results, while tables 3.8 and 3.9 give the Probit marginal effect estimates for a sense of the quantitative magnitude of the effects we find. Table 3.10 gives the results using the logarithm of the Z-score as the dependent variable, as a robustness check to ensure that the results are insensitive to the choice of Z-score cut-off in the binary response analysis.

Note that the signs of the Probit estimation coefficients, Tables 3.6 and 3.7, give the direction of the effects, but the coefficients themselves do not give a sense of the magnitude of the effect. This is due to the fact that the coefficient magnitudes are in the units of the standard errors. In Table 3.6, the specifications in columns (1)-(3) contain slightly different explanatory variables that cannot all be included in one specification due to collinearity problems. For example, (1) includes the HDI index of human development, which is highly collinear with the access to international markets indicator variable included in (3). Similarly in Table 3.7, various specifications are explored for robustness to different explanatory variables. For example, the inclusion of the Net Interest Margin variable in (3) is highly collinear with a bank's proportion of loan loss provisions to gross loans.

For a sense of true magnitude, we separately calculate the average marginal effects for the explanatory variables to obtain the discrete change in probability of banking distress averaged across the sample values of the other predictor variables. These estimates are given in Tables 3.8 and 3.9. For example, to calculate the average predicted probability of distress for a given percentage of adults saving, the predicted probability was calculated for each bank-year, using that bank's values of explanatory variables for that year, and the average was taken across all these predicted probabilities.

In Table 3.8, column 1, the marginal effect of the adults saving percentage tells us that the derivative of the mean expected probability of bank distress with respect to adults saving is -0.272. This suggests that if we had 4 banks and then increased the percentage of adults saving by 1%, this would cause one bank to switch from being likely to default to being unlikely to. The .0371 coefficient on SME access constraint suggests that if we had 27 banks and then lowered the SME access constraint by 1%, this would cause one bank to switch from being likely to default to being unlikely to. The .449 coefficient on percentage of adults borrowing suggests that, of just 2.2 high default probability banks, one would become more solvent and unlikely to default if adult borrowing decreased by 1%. The coefficient magnitudes in columns 2-3 are nearly identical.

In Table 3.9, column 1, using the percentage small firm credit line variable as a measure of SME financial access instead, we have the same directional effects on all variables but the magnitudes of the effects differ. There, the marginal effect of adults saving percentage on probability of bank distress is equal to -0.046. This suggests that if we had 22 banks and increased the percentage of adults saving by 1%, this would cause one bank to switch from being likely to default to being unlikely to. The .057 coefficient on adults borrowing suggests that, of 18 high default probability banks, one would become more solvent and unlikely to default if adult borrowing decreased by 1%. The -.0365 coefficient on percentage of small firms with a credit line suggests that a 1% increase in the percentage of small firms with a credit line leads to a .037% decrease in probability of distress.

Table 3.10 shows the results obtained using the dependent variable ln (Z-score), renormalized so that negative Z-score observations are also reflected[5]. The first two columns represent the estimation comparing individual access to firm-level access, using the SME Access Constraint of firm-level financial access. The last two columns represent the estimation comparing individual access to firm access, using the small firm credit line percentage measure. The interpretation of these coefficients follows straight from the table and support the Probit estimation results in both the directional effect and the magnitude effect of variables.

Focusing on the SME Access Constraint measure, Table 3.10, column 1, we find that a 1% increase in the percentage of adults saving improves bank stability as measured by the

[5]Detailed explanation of renormalization in variable explanations in Appendix.

Z-score by 7.42%. A 1% increase in adults borrowing reduces the Z-score by 3.83% and a 1% increase in SME access constraint is associated with a 5.74% reduction in the Z-score measure of stability. Using the small firm credit line measure of SME financial access, see Table 3.10, column 3, we find results consistent with the SME access measure of inclusion. A 1% increase in percentage of adults saving is associated with a 4.11% increase in Z-score-measured bank stability, a 1% increase in small firms with a credit line leads to a 1.55% increase in the Z-score, while a 1% increase in percentage of adults borrowing leads to a 5.92% decrease in stability. As expected and consistent with the Probit analysis, term deposits to assets and return on average equity both have positive and significant causal effects on bank stability, while banks' total asset growth has a negative impact on stability.

3.5 Conclusion

3.5.1 Main Findings

The results of the empirical analysis in this chapter suggest the following broad findings for selected MICs in SSA.

First, the financial landscape in SSA MICs has deepened over the past decades, as reflected in an increasing share of the stock of private credit to GDP and deposits as ratio to GDP. Furthermore, their return on assets has stabilized to a lower level, consistent with a maturing and more competitive financial sector in SSA MICs.

Second, in many of the MICs in SSA, one reason for the low level of financial inclusion is SME's lack of access to finance. Our study results show that SME access to finance has a positive and significant impact on financial stability. Financial usage can have stabilizing effects on the financial sector by helping to increase financial sector depth. If borrowing tends to be used for investment purposes or to finance asset purchases generating returns, overall this would be beneficial to the financial sector and the economy in general. Thus, financial inclusion focusing on enhancing SME access to finance tends to enhance financial stability.

Furthermore, another reason for the low level of financial inclusion is that relatively poor households do not have access to bank accounts due to various reasons such as the minimum balance requirement, fees for opening or maintaining a bank account with low balance, or absence of financial institutions in lower income communities. Therefore, financial inclusion focusing on improving households' access to bank accounts will enhance financial stability. Specifically policy measures such as reducing or eliminating the minimum balance requirement or fees for opening/maintaining bank accounts with lower balances should increase inclusion. Alternatively, using new technology such as e-banking or mobile banking will facilitate the population's access to finance.

Moreover, financial inclusion that overly relies on increasing households' access to credit by lowering lending standards encouraging low quality creditors to take out unaffordable loans/mortgages can be destabilizing. In the short run, these policies may mechanically increase financial inclusion, but in the long run, this will likely jeopardize financial stability which will ultimately undermine financial inclusion.

Finally, the primary components of global regulatory reforms will likely steer banks' funding structures further toward deposits and equity with less reliance on short-term wholesale funding. This funding structure will likely have a positive impact on financial stability.

3.5.2 Policy implications

We would like to draw the following key policy messages from the above findings. First, policies promoting SME sector development should enhance financial stability. Second, reforms that facilitate individuals' access to savings accounts will also promote financial stability. However, mechanically expanding the number of people with credit may lead to over indebtedness. This could undermine financial stability. In a number of countries, the authorities tend to overly promote loans to households in pursuit of greater financial inclusion. This has led to over indebtedness of households. Finally, global regulatory reforms will likely have a positive impact on financial stability by shifting banks' funding structure more towards capital and deposits.

However, our results and messages should be interpreted with some caution. There are no one-size-fits-all approaches to striking an appropriate balance between financial inclusion and financial stability. The policy of enhancing financial stability of each country has to take into consideration its country-specific circumstances.

3.6 Appendix

Box 3.1. Derivation of Z-Score

Banks' probability of distress is defined as the probability that it defaults, i.e. consolidated profit is less than consolidated equity:

$$p(\tilde{\pi} < -E) = p\left(\frac{\tilde{\pi}}{A} < -\frac{E}{A}\right)$$

Let the following notation hold:

$$\tilde{r} \equiv \frac{\tilde{\pi}}{A} = ROA$$

$$k \equiv -\frac{E}{A} = -CAR$$

Then, assuming that the distribution of ROA satisfies $\tilde{r} \equiv \frac{\tilde{\pi}}{A} \sim N(\mu, \sigma) \Rightarrow \frac{\tilde{r} - \mu}{\sigma(\tilde{r})} \sim N(0,1)$

Then, probability of bank distress can be written as:

$$p\left(\frac{\tilde{\pi}}{A} < -\frac{E}{A}\right) = p(\tilde{r} < k) \Rightarrow p\left(\frac{\tilde{r} - \mu}{\sigma(\tilde{r})} < \frac{k - \mu}{\sigma(\tilde{r})}\right) = \Phi\left(\frac{k - \mu}{\sigma(\tilde{r})}\right)$$

$$= \int_{-\infty}^{\frac{k-\mu}{\sigma(\tilde{r})}} \phi(x)dx = \int_{-\infty}^{-Z} \phi(x)dx$$

Thus the definition of the bank Z-score, $Z \equiv \frac{\left(\frac{E}{A} + ROA\right)}{\sigma(ROA)}$, is a direct inverse measure of the likelihood of bank distress.

Box 3.2. Derivation of Z-Score Threshold in Binary Estimation

Since Z-score is inversely related to p(distress), if we look at the case when the p(distress)>p_{10}(distress), the 10[th] percentile of default probabilities, then we have that:

$$p(distress) > \Phi(p_{10}) \Rightarrow -p(distress) < \Phi(p_{10})$$

$$\Rightarrow -\Phi^{-1}[p(distress)] < p_{10}$$

And since $Z = -\Phi^{-1}[p(distress)] \Rightarrow Z < p_{10}$, exploring the case of a 10 percentile threshold on distress probability, is equivalent to exploring the case when Z< p_{10}(Z), i.e. Z<2.435

3.6.1 Explanation of Independent Variables

Bank-level Variables

Herfindahl Index The Herfindahl index of bank funding relates to the diversity of a bank's funding structure. It is calculated as the sum of the squares of the share of funding attributed respectively to deposits, debt, and equity, with higher values implying lower diversity in funding structure: (Customer Deposits/Assets)2 + (Equity/Assets)2 + (Non-Deposit Debt/Assets)2. Diversity of funding is important as it has been found that banks with weaker pre-financial crisis structural liquidity and higher leverage were more likely to fail during the crisis[6]. We expect that greater bank funding diversity should reduce the risk of fallout from inadequacy of any individual source of funding.

Loan-Customer Deposits Ratio Bank loan-deposit (LTD) ratios are standard indicators of bank liquidity. Ex ante, we would expect higher LTD ratios to be associated with greater risk of instability. LTD ratios of less than one indicate that a bank used its own deposits to make loans to customers without resorting to outside borrowing and re-loaning. High LTD ratios mean that banks may not have the liquidity to cover unexpected funding obligations or periods of financial crises.

Short-term debt to Assets Ratio The short-term (ST) debt (debt maturing with one year) to asset ratio is a financial leverage ratio. If this ratio is very high, it indicates that the bank may not have enough cash or cash equivalents to pay off ST debts. High levels of ST debt exposes a bank to high borrowing costs that could negatively affect profits. ST debt is more vulnerable to sudden increases in the interest rate or fluctuations in investor confidence. It has been shown that ST debt is a better indicator for financial crisis than even the oft-used private credit to GDP measure[7]. On the other hand, countries with underdeveloped legal environments for disclosure and investor protection have limited long-term debt capacity, thus ST debt is a necessity for financing illiquid investments (particularly of the low-credit variety associated with new borrowers[8]). In this sense, high ST debt to asset ratios may be unavoidable and not necessarily immediately indicate instability. In our sample, we do find a non-linear relationship between ST debt to assets and bank stability under the ln(Z-score) measure (see Figure 3.4).

Equity to Assets Ratio The equity to assets ratio is a leverage ratio used to determine the amount of assets on which shareholders have a residual claim, in other words, how much shareholders would receive in the event of bank liquidation. In the aftermath of the global financial crisis it has been widely considered that banks funding with too little equity create a fragile and distorted financial system more prone to crisis[9].

[6] Bank Funding Structures and Risk: Evidence from the Global Financial Crisis. IMF Working Paper WP/12/29. Prepared by Francisco Vazquez and Pablo Federico

[7] "Short-term Debt and Financial Crises." Krishnamurthy, A. and A. Vissing-Jorgensen (2012). Kellogg School, Northwestern University.

[8] "Banks, Short Term Debt and Financial Crises: Theory, Policy Implications and Applications." Diamond & Rajan, 2001.

[9] "The Bankers' New Clothes," Anat Admati and Martin Hellwig.

Term Deposits to Assets Term deposits are customer deposits that have a fixed maturity date, are interest-bearing and are not subject to immediate and unlimited withdrawal by the depositor. Higher proportions of term deposits are associated with more long-term bank stability and are used by ratings agencies such as Moody's in bank stability ratings, with higher ratios corresponding to higher stability ratings.

Return on Average Equity Return on average total equity measures how much profit a company generates with the money shareholders have invested. This percentage represents the average return across various types of equity: common equity, non-controlling interest, securities revaluation reserves and other accumulated comprehensive income. Generally, the greater the return on equity, the better is the profitability of the bank and thus we would expect this variable to be negatively correlated with probability of distress.

Loan Loss Provisions to Gross Loans The loan loss provision (LLP) to gross loans ratio is an indicator of the amount of capital buffers. LLPs represent an expense set aside as an allowance for NPLs. In general, the greater the proportion of LLPs to gross loans, the more stable the bank should be as it has buffers in place in the event of potential capital shortfalls.

Net Interest Margin Total interest income less total interest expense (annualized) as a percent of average earning assets. This indicator measures how successful a firm's investment decisions are relative to its debt. A negative value implies that interest expenses were greater than the amount of returns generated by investments and thus NIM is expected to be positively correlated with stability.

Size Bank size is measured by a bank's total assets. Assets are what a bank owns, including loans, reserves, investment securities, and physical assets. Total assets are as reported rather than weighted according to perceived risk of potential loss. It has traditionally been an important determinant of bank stability, although this relationship can be non-linear, as shown in this sample with respect to the ln(Z-score) measure (see Figure 3). Higher levels of bank assets can help to improve stability in terms of covering potential losses, however very high levels of assets can speak to the existence of easy credit and excess loans which may end up as destabilizing NPLs.

Total Asset Growth A moderate growth rate usually indicates stable or improving bank finances. A declining growth rate may indicate a sluggish economy or can be an indicator of internal bank problems. Generally, a rapid asset growth rate is thought to be undesirable if opportunities to place the growth into high quality earning assets do not exist. Asset growth likely has a non-linear relationship with stability and should be managed in a manner that will not adversely impact the quality of the bank's investments, the bank's liquidity position or its capital adequacy.

Country-level Variables

Percentage of Adults Saving This indicator measures individual financial usage for saving purposes. This indicator is based on the Global Findex household survey. Savings can contribute in several ways to overall financial stability. If household savings are used by banks efficiently in generating return, this has a positive effect on the growth and the overall financial environment .

Percentage of Adults Borrowing The percentage of adults borrowing is another measure of individual financial usage based on borrowing. The indicator is derived from the Global Findex survey. Household borrowing tends to be used to finance consumption[10], this type of access can be destabilizing if it leads to over-indebtedness of households.

SME Access Constraint The percentage of SMEs identifying access to finance as a major constraint is an indicator for firm-level financial access. It is based on SME survey responses to the World Bank Enterprise Survey question: "Is access to finance a significant constraint for your firm?" Similar to individual financial access, small firm financial access can have positive effects on financial deepness and generally spur investment and economic growth with many spillovers to the financial sector. However, if financial access leads to an increase in indebtedness with poor investment choices corresponding to low returns on investment, access itself may not be stabilizing.

Percentage of Small Firms with Credit Line The percentage of small firms with a credit line to total small firms is an alternative indicator for small firm financial access derived from the WB Enterprise Survey. Similar to the SME access constraint, the specific usage of the credit line has much to do with whether this type of access has a positive or negative contribution to financial stability.

[10] A study done by Johnston and Morduch (2008) in Indonesia showed that about half the volume of borrowing by poor households is for non-business purposes, including consumption.

GDP per capita This indicator is measured in constantprice USD. Higher levels of GDP per capita indicate greater overall macroeconomic development, which is generally stability promoting.

GDP growth This indicator (annual % growth rate of GDP at market prices based on constant 2005 USD) is an indicator of the speed of economic growth. It relates to overall macro-level financial stability in a generally positive way but excessively high growth rates may point to overheating.

GDP growth-Bank Size Interaction Since banks of different sizes may be affected differently by GDP growth, an interaction term between the two variables is included.

Interest Rate Spread The interest rate spread is the average lending rate minus average deposit rate. It is a measure of overall financial sector profitability and we would expect higher spreads to correspond to reduced likelihoods of distress.

Inflation, GDP deflator Inflation as measured by the annual growth rate of the GDP implicit deflator shows the rate of price change in the economy as a whole. The GDP implicit deflator is the ratio of GDP in current local currency to GDP in constant local currency. Banks in higher-inflation countries are subject to greater nominal uncertainty, but on the other hand this uncertainty can be easily hedged, so it is not clear ex ante the exact directional impact of this variable[11].

Stock Market Volatility This is the Bloomberg volatility of stock price index, 360-day standard deviation indicator. Lower volatility is generally considered beneficial to banking stability in reducing uncertainty and as a signal of a broadly stable financial environment. However, the stock markets in SSA are relatively underdeveloped, with very few listed firms, thus this measure may not be as important under this backdrop.

Legal Index This is an index of the strength of banking regulation, which should contribute positively to banking stability. It measures the degree to which collateral and bankruptcy laws protect the rights of borrowers and lenders and thus facilitate lending. The index ranges from 0 to 10, with higher scores indicating that these laws are better designed to expand access to credit.

[11] Conflicting relationships between inflation and probability of bank distress were found using different measures of distress. The z-score model saw a positive relationship between inflation and distress while using price-book ratio or analyst ratings the result was the opposite. This indicates potentially hedging against inflation with stocks or other unobservable effects.

HDI The Human Development Index is a composite index measuring average achievement in three basic dimensions of human development—a long and healthy life, knowledge and a decent standard of living. Including this variable was done in order to control for many social and structural unobservables that may be adding noise to the relationship between financial access and stability.

International Market Access Access to international markets can be a sign of financial sector development. Based on the WEO 2012, we identify the following countries in our sample as having access to international markets: Ghana, Namibia, Senegal, Seychelles, South Africa and Zambia.

Stock Market Capitalization Total stock market capitalization is the total value of issued shares of all publicly traded companies in the economy. It is an additional indicator for financial sector development.

Table 3.1 Countries in the Sample

Botswana (BW)	Senegal (SN)
Cape Verde (CV)	Seychelles (SC)
Ghana (GH)	South Africa (ZA)
Lesotho (LS)	Swaziland (SZ)
Mauritius (MU)	Zambia (ZM)
Namibia (NA)	

Table 3.2. Definition of variables and sources

Variable	Description	Sources
Dependent Variables		
Z-dummy, P(z<10th percentile)	A dummy variable for thte Z-score, 0 indicates Z-score≧x corresponding to greater stability, 1 indicates Z-score<x signalling higher chance of distress. Various x thresholds are used, but the primary x is the bottom 10th percentile of bank Z-scores in the sample	Bankscope
ln(Z-score)	Natural logarithm of the Z-score + min(Z-score); this normalization is done to include the negative Z-score values which cannot be logged, thus all numbers are relative to the lowest bank Z-score within sample	Bankscope
Z-score	(Equity2Assets+ROAA)/σ(ROA), ROAA is the average Return on Assets across a firms various assets, σ(ROA) is the standard deviation of a bank's ROA over the available sample period	Bankscope
Bank-Level Independent Variables		
Linear relation variables		
Loans2CustDep	Total Loans to Total Customer Deposits	Bankscope
Herfindahl	A measure of the diversity of bank funding (higher values indicate less diverse), calculated as (CustomerDeposits/Assets)^2 + (Equity/Assets)^2 + (Debt/Assets)^2	Bankscope
TermDep2Assets	Term deposits to Assets	Bankscope
Equity2Assets	Equity to Assets	Bankscope
ROE	Return on Average Equity, average ROE across all banks' equities	Bankscope
TotAssetGrowth	Total Asset Growth	Bankscope
LoanLossProv2GrossLoan	Loan Loss Provisions to Gross Loans	Bankscope
Net Interest Margin	Total interest income less total interest expense (annualized) as a percent of average earning assets.	Bankscope
Non-linear spline variables		
Size	Total assets. Cubic splines used with knots at 0 20000 40000 5000000 25000000. Splines chosen using local linear polynomial smoothing non-parametric estimation.	Bankscope
STfund2Assets	Short-term funding to Assets, ST funding calculated as Deposits & ST Funding - Customer Deposits. Cubic splines used with knots at 0 1 20 350 700 1000. Splines chosen using local linear polynomial smoothing non-parametric estimation.	Bankscope

Country-Level Independent Variables

GDP growth	Annual percentage growth rate of GDP at market prices based on constant local currency. Aggregates are based on constant 2005 U.S. dollars. GDP is the sum of gross value added by all resident producers in the economy plus any product taxes and minus any subsidies not included in the value of the products. It is calculated without making deductions for depreciation of fabricated assets or for depletion and degradation of natural resources. Cubic splines in log regression with knots at -10 -3 0 10 15.	World Bank national accounts data, and OECD National Accounts data files.
GDPpc_nom	GDP per Capita in U.S. Dollars, Nominal. GDP per capita, current prices U.S. dollars.	WEO, indicator 'NGDPDPC'.
gGDPxSize	A constructed interaction term between GDP growth and Bank Size (Total Assets).	World Bank national accounts data, OECD National Accounts data files and Bankscope.
GDP Deflator, Annual%	Inflation as measured by the annual growth rate of the GDP implicit deflator shows the rate of price change in the economy as a whole. The GDP implicit deflator is the ratio of GDP in current local currency to GDP in constant local currency.	World Bank national accounts data, and OECD National Accounts data files.
Legal Index	Strength of legal rights index (0=weak to 10=strong), measures the degree to which collateral and bankruptcy laws protect the rights of borrowers and lenders and thus facilitate lending. The index ranges from 0 to 10, with higher scores indicating that these laws are better designed to expand access to credit.	World Bank, Doing Business project (http://www.doingbusiness.org/).
HDI	Human Development Index, A composite index (0=low to 1=high) measuring average achievement in three basic dimensions of human development—a long and healthy life, knowledge and a decent standard of living. See Technical note 1 for details on how the HDI is calculated.	HDRO calculations based on data from UNDESA (2011), Barro and Lee (2011), UNESCO Institute for Statistics (2012), World Bank (2012) and IMF (2012).
stockvolatility_yr	The 360-day price volatility equals the annualized standard deviation of the relative price change for the 360 most recent trading days closing price, expressed as a percentage.	Bloomberg, indicator 'VOLATILITY_360D'
Adults Saving %	Adults saving at a fin. inst. in the past year to total adults (%). Percentage of adults who report saving or setting aside any money using an account at a formal financial institution such as a bank, credit union, microfinance institution, or cooperative in the past 12 months. The data is from world-wide household survey.	Aslı Demirgüç-Kunt and Leora Klapper, 2012. "Measuring Financial Inclusion: The Global Findex," World Bank Policy Research Working Paper 6025
Adults Borrowing %	Adults borrowing from a formal fin. inst. in the past year to total adults (%). Percentage of adults who report borrowing any money from a bank, credit union, microfinance institution, or another financial institution such as a cooperative in the past 12 months. The data is from world-wide household survey.	Aslı Demirgüç-Kunt and Leora Klapper, 2012. "Measuring Financial Inclusion: The Global Findex," World Bank Policy Research Working Paper 6025.
smallfirmcreditline%	Small firms with line of credit to total small firms (%). Proportion of small firms in the formal sector with a line of credit or a loan from a financial institution.	World Bank – Enterprise Survey
SME Access Constraint	Percent of small (5-19 Employees) and medium (20-99) firms identifying access to finance as a major constraint, equal-weighted average of percent for each size class	World Bank – Enterprise Survey

Table 3.3. Banks by Country, 1998–2013

BW	CV	GH	LS	MU	NA	SC	SN	SZ	ZA	ZM	Total
17	7	39	5	21	12	7	13	7	65	34	227

Table 3.4. Descriptive Statistics, 1998-2013

Variable	N	μ	SD	Min	Max
lnzscore1	1653	3.201068	0.578297	-2.30258	9.332544
zscore	1653	31.37786	393.5484	-11.6893	11288.05
Size	1665	220856.9	1216863	1.53366	2.48E+07
Loans/CustomerDeposits	1000	94.07715	90.40501	0.04	948.04
Herfindahl	1351	149680.4	1598492	0.334504	2.29E+07
ST Funding/Assets	1351	2.865433	43.32756	0	958.3101
ST Funding/Debt	1349	0.315373	0.569755	-2.08377	11.69209
Debt/Assets	1351	-26.2917	272.3613	-3384.5	1.079327
Equity/Assets	1665	0.207597	0.240067	-2.06748	1
TotAssetGrowth	1209	25.24787	49.32051	-79.84	557.54
LoanLossProv/GrossLoans	1292	0.021177	0.046329	-0.27624	0.670588
GDPgrowth	3405	4.465375	2.813679	-7.87845	15.01095
GDPpercapita	3632	3453.237	2806.125	303.6292	12207.16
GDPgrowthxSize	1438	1121335	7484720	-1.85E+07	1.48E+08
Inflation_Annual%	3405	10.91715	10.59479	-5.65271	80.70409
Legal Index	2022	7.693867	2.113726	3	10
Stock Market Volatility	1735	16.88453	7.579253	3.7	42.68
HDI	2008	0.56607	0.100146	0.376	0.806
Adults Saving/Adults	2741	17.95975	7.042636	3.716611	30.83022
Adult Borrowing/Adults	2741	7.823875	3.019812	3.040511	14.27377
SME Access Constraint	1414	34.22415	19.2902	16.7	68.4
Small Firm Credit Line%	3520	21.4335	11.43403	6.27	41.01

Sources: Bankscope, WEO, Bloomberg, WB – Enterprise Survey, WB – Doing Business Project and Aslı Demirgüç-Kunt and Leora Klapper, 2012. "Measuring Financial Inclusion: The Global Findex," World Bank Policy Research Working Paper 6025.

Bank Z-score Average Decomposition by Country

Countryname	Avg. (Equity /Assets) /sd(ROA)	Avg. ROA /sd(ROA)	E2A+ROA	sd(ROA)
Botswana	13.32333	2.458211	0.384887	0.02541
Cape Verde	24.96254	2.361218	0.085446	0.036068
Ghana	18.82223	3.910805	0.194801	0.024611
Lesotho	10.20203	2.400841	0.158145	0.016233
Mauritius	18.27191	2.159558	0.230563	0.052533
Namibia	26.56134	4.987165	0.306837	0.033309
Senegal	22.09589	1.405767	0.107556	0.014649
Seychelles	6.46428	0.906679	0.221576	0.034035
South Africa	16.33315	2.176708	0.282107	0.038034
Swaziland	11.61753	2.033957	0.19593	0.017131
Zambia	90.11909	6.282986	0.150728	0.066676

Table 3.5. Correlation matrix between variables

	Z-score	Size	Loans 2Dep	Herf	STfund 2A	TermD ep2A	Tot Asset Growth	Loan Loss Prov's	Int Rate Spread %	Net Interest Margin	GDP growth	GDPpc _nom	gGDPx Size	Inflation _Ann%	Legal Index	stock vol_yr	Intl Mkt	HDI	Adults Saving %	Adults Borrow ing %	SME Access Constr aint
Size	-0.04	1.00																			
Loans2CustDep	-0.06	-0.11	1.00																		
Herfindahl	-0.04	-0.07	-0.07	1.00																	
STfund2Assets	-0.03	-0.05	-0.06	0.60	1.00																
TermDep2Assets	-0.06	-0.10	-0.12	0.49	0.09	1.00															
TotAssetGrowth	0.22	-0.04	-0.07	-0.01	0.00	0.02	1.00														
LoanLossProvisions	0.03	0.00	0.18	0.08	-0.03	0.05	0.14	1.00													
IntRateSpread_%	0.34	0.40	-0.16	0.18	0.18	0.25	0.05	0.12	1.00												
NetInterestMargin	0.04	0.04	0.11	-0.01	0.02	0.01	0.14	0.69	0.20	1.00											
GDPgrowth	0.34	0.27	-0.18	0.11	0.07	0.14	0.14	-0.04	0.51	0.02	1.00										
GDPpc_nom	-0.37	-0.45	0.18	-0.24	-0.17	-0.32	-0.12	-0.14	-0.78	-0.26	-0.38	1.00									
gGDPxSize	-0.01	0.97	-0.13	-0.06	-0.04	-0.08	-0.01	0.03	0.44	0.10	0.37	-0.49	1.00								
Inflation_Ann%	0.15	0.28	-0.06	0.20	0.13	0.27	0.05	0.19	0.61	0.26	0.06	-0.70	0.27	1.00							
LegalIndex	-0.07	0.12	0.11	0.01	0.01	0.01	0.01	0.18	0.12	0.25	-0.33	-0.26	0.05	0.57	1.00						
stockvolatility_yr	-0.10	0.01	0.10	0.00	0.01	-0.02	-0.04	0.15	-0.02	0.20	-0.54	-0.29	-0.04	0.43	0.58	1.00					
IntlMkt	0.04	0.24	0.03	0.08	0.05	0.10	0.04	0.20	0.31	0.29	-0.19	-0.52	0.20	0.71	0.95	0.57	1.00				
HDI	-0.36	-0.45	0.15	-0.25	-0.17	-0.34	-0.10	-0.16	-0.87	-0.28	-0.44	0.92	-0.49	-0.73	-0.40	-0.16	-0.61	1.00			
Adults Saving %	-0.35	-0.43	0.11	-0.20	-0.14	-0.27	-0.09	-0.14	-0.85	-0.26	-0.47	0.77	-0.46	-0.62	-0.40	-0.07	-0.54	0.95	1.00		
Adults Borrowing %	-0.25	-0.33	0.03	-0.14	-0.10	-0.19	-0.06	-0.14	-0.71	-0.26	-0.33	0.57	-0.34	-0.55	-0.55	-0.14	-0.59	0.82	0.94	1.00	
SME Access Constraint	0.04	-0.13	-0.12	-0.01	-0.01	-0.02	-0.01	-0.17	-0.22	-0.26	0.21	0.22	-0.07	-0.52	-0.95	-0.48	-0.87	0.45	0.54	0.73	1.00
Small Firm Credit %	-0.29	-0.44	0.11	-0.19	-0.14	-0.26	-0.09	-0.19	-0.71	-0.30	-0.22	0.88	-0.45	-0.80	-0.63	-0.34	-0.82	0.93	0.83	0.72	0.59

Table 3.6. Probit Results with SME Access Constraint

P(z<10th percentile)	(1) β/(se)	(2) β/(se)	(3) β/(se)
L.Herfindahl	0.00000*	0.00000	0.00000
	(0.000)	(0.000)	(0.000)
L.Loans2CustDep	0.01116***	0.00095	0.00095
	(0.00300)	(0.00200)	(0.00200)
L.STfund2Assets	-6.18513	-2.93280	-2.93280
	(6.20700)	(3.32900)	(3.32900)
L2.STfund2Assets	0.00119	-0.001	-0.001
	(0.00200)	(0.00100)	(0.00100)
L3.STfund2Assets	0.00309*	0.00232	0.00232
	(0.00200)	(0.00200)	(0.00200)
L.Equity2Assets	-24.89546***		
	(7.14300)		
L.TermDep2Assets	-0.00224**	-0.0008	-0.0008
	(0.00100)	(0.00100)	(0.00100)
L.ROE	-3.54839**	-1.63355**	-1.63355**
	(1.64300)	(0.67100)	(0.67100)
L.LoanLossProv2GrossLoan	-10.61184	4.74026	4.74026
	(11.05500)	(6.54000)	(6.54000)
L.TotAssetGrowth	0.02746***	0.01251*	0.01251*
	(0.00700)	(0.00700)	(0.00700)
L.NetInterestMargin	10.01259*	-0.63379	-0.63379
	(5.77200)	(4.75800)	(4.75800)
L.Size	0.00000	0.00000	0.00000
	(0.000)	(0.000)	(0.000)
GDPpc_nom	0.00474*	0.00268*	0.00268*
	(0.00300)	(0.00100)	(0.00100)
GDP growth	0.65102	0.3751	0.3751
	(0.54000)	(0.31100)	(0.31100)
gGDPxSize	0.00000	0.00000	0.00000
	(0.000)	(0.000)	(0.000)
GDP Deflator, Annual %	-0.19501	-0.11286	-0.11286
	(0.13200)	(0.08400)	(0.08400)
Legal Index	2.9162	2.01571	
	(2.41700)	(1.66000)	
stockvolatility_yr	0.0377	0.01677	0.01677
	(0.17500)	(0.14800)	(0.14800)
Adults Saving %	-4.83314**	-3.93577**	-3.64167***
	(1.95300)	(1.57000)	(1.35100)
Adults Borrowing %	7.96746**	6.06925**	5.53828***
	(3.33900)	(2.49800)	(2.09400)
SME Access Constraint	0.65952*	0.40109**	0.32494**
	(0.34400)	(0.19900)	(0.14400)
HDI	-61.73422		
	(63.76000)		
IntlMkt			5.51400
			(4.54100)
Constant	-12.49163	-22.44162	-8.31335
	(22.18200)	(19.61900)	(8.33900)
r2_p	0.68179	0.5589	0.5589
N	215	215	215

* p<0.10, ** p<0.05, *** p<0.01

Table 3.7. Probit Results with Small Firm Credit Line (%)

	(1)	(2)	(3)
P(z<10th percentile)	β/(se)	β/(se)	β/(se)
L.Herfindahl	0	0	0
	(0.000)	(0.000)	(0.000)
L.Loans2CustDep	0.00085	-0.0019	0.00099
	(0.00200)	(0.00200)	(0.00200)
L.STfund2Assets	-0.01606	-0.02268	-0.01656***
	(0.01100)	(0.01400)	(0.00600)
L2.STfund2Assets	-0.00145	-0.00117	-0.00104
	(0.00100)	(0.00100)	(0.00100)
L3.STfund2Assets	0.00092	0.00135	0.0013
	(0.00100)	(0.00100)	(0.00100)
L.TermDep2Assets	-0.00119	-0.00086	-0.00036
	(0.00100)	(0.00100)	(0.00100)
L.ROE	-2.00730***	-1.89913***	-2.33243***
	(0.72200)	(0.65900)	(0.70800)
L.LoanLossProv2Gro~n	2.57645	-2.89233	
	(6.79900)	(3.66900)	
L.TotAssetGrowth	0.00566	0.00791*	0.00502
	(0.00500)	(0.00500)	(0.00500)
L.Size	0.00000	-0.00000**	-0.00000***
	0.00000	0.00000	0.00000
GDPpc_nom	0.00127*	0.00017	0.00114*
	(0.00100)	0.00000	(0.00100)
GDP growth	0.26249	0.10859*	0.21948
	(0.20000)	(0.05600)	(0.18500)
gGDPxSize	0.00000		
	0.00000		
Legal Index	-3.16161***	0.056	-3.12484***
	(1.16800)	(0.12000)	(1.04400)
stockvolatility_yr	0.04618		0.0388
	-(0.066)		(0.06000)
Adults Saving %	-0.53759***	-0.16423*	-0.48906***
	(0.17200)	(0.09500)	(0.16200)
Adults Borrowing %	0.67246**	0.21843	0.57673**
	(0.27800)	(0.14700)	(0.26100)
smallfirmcred	-0.43026*	-0.03831	-0.38786*
	(0.24000)	(0.03000)	(0.20800)
GDP Deflator, Annu~%		0.00433	
		(0.04000)	
L.NetInterestMargin			3.12141
			(3.37300)
Constant	29.64098***	-0.92981	28.91478***
	(9.45800)	(0.99700)	(8.67800)
r2_p	0.50073	0.27461	0.4507
N	229	329	243

* p<0.10, ** p<0.05, *** p<0.01

Table 3.8. Probit Estimation Marginal Effects using SME Access Constraint

P(z<10th percentile)	(1) dy/dx	(2) dy/dx	(3) dy/dx
L.Herfindahl	0.00000*	0.00000	0.00000
L.Loans2CustDep	0.00063***	0.00007	0.00007
L.STfund2Assets	-0.34823	-0.22143	-0.22143
L2.STfund2Assets	0.00007	-0.00008	-0.00008
L3.STfund2Assets	0.00017*	0.00018	0.00018
L.TermDep2Assets	-0.00013**	-0.00006	-0.00006
L.ROE	-0.19978**	-0.12333**	-0.12333**
L.LoanLossProv2GrossLoan	-0.59746	0.35789	0.35789
L.TotAssetGrowth	0.00155***	0.00094*	0.00094*
L.NetInterestMargin	0.56372*	-0.04785	-0.04785
L.Size	0.00000	0.00000	0.00000
GDPpc_nom	0.00027*	0.00020*	0.00020*
GDP growth	0.03665	0.02832	0.02832
gGDPxSize	0.00000	0.00000	0.00000
GDP Deflator, Annual %	-0.01098	-0.00852	-0.00852
Legal Index	0.16419	0.15219	
stockvolatility_yr	0.00212	0.00127	0.00127
Adults Saving %	-0.27211**	-0.29715**	-0.27495***
Adults Borrowing %	0.44858**	0.45824**	0.41815***
SME Access Constraint	0.03713*	0.03028**	0.02453**
IntlMkt			0.41631
HDI	-3.4757		
r2_p	0.68179	0.5589	0.5589
N	215	215	215

* p<0.10, ** p<0.05, *** p<0.01

Table 3.9. Probit Estimation Marginal Effects using Small Firm Credit Line (%)

P(z<10th percentile)	(1) dy/dx	(2) dy/dx	(3) dy/dx
L.Herfindahl	0.00000	0.00000	0.00000
L.Loans2CustDep	0.00007	-0.00023	0.00009
L.STfund2Assets	-0.00136	-0.00274	-0.00151***
L2.STfund2Assets	-0.00012	-0.00014	-0.00009
L3.STfund2Assets	0.00008	0.00016	0.00012
L.TermDep2Assets	-0.0001	-0.0001	-0.00003
L.ROE	-0.17041***	-0.22908***	-0.21261***
L.LoanLossProv2GrossLoan	0.21873	-0.34889	
L.NetInterestMargin			0.28454
L.TotAssetGrowth	0.00048	0.00095*	0.00046
L.Size	0.00000	-0.00000**	-0.00000***
GDPpc_nom	0.00011*	0.00002	0.00010*
GDP growth	0.02228	0.01310*	0.02001
gGDPxSize	0.00000		
GDP Deflator, Annual %		0.00052	
Adults Saving %	-0.04564***	-0.01981*	-0.04458***
Adults Borrowing %	0.05709**	0.02635	0.05257**
Small firm credit line %	-0.03653*	-0.00462	-0.03536*
Legal Index	-0.26841***	0.00676	-0.28485***
stockvolatility_yr	0.00392		0.00354
r2_p	0.50073	0.27461	0.4507
N	229	329	243

* p<0.10, ** p<0.05, *** p<0.01

Table 3.10. Results using ln(Z-score) as Dependent Variable

ln(Z-score)	(1) β/(se)	(2) β/(se)	(3) β/(se)	(4) β/(se)
L.Herfindahl	0.00000		0.00000	0.00000
	(0.000)		(0.000)	(0.000)
L.Loans2CustDep	0.00000	0.00033	0.00019	0.00035
	(0.000)	(0.000)	(0.000)	(0.000)
L.TermDep2Assets	0.00047***	0.00034***	0.00025**	0.00013
	(0.000)	(0.000)	(0.000)	(0.000)
L.ROE	0.32612***	0.35271***	0.27791***	0.31812***
	(0.125)	(0.134)	(0.086)	(0.082)
L.LoanLossProv2GrossLoan	1.14680*		-1.34665*	
	(0.655)		(0.729)	
L.TotAssetGrowth	-0.00130***	-0.00116***	-0.00112***	-0.00123***
	(0.001)	(0.000)	(0.000)	(0.000)
GDPgrowth	-0.02562**	-0.01941	-844.59794	-1253.62682
	(0.012)	(0.012)	(1387.495)	(1322.511)
gGDPxSize			0.00000	
			(0.000)	
IntRateSpread_pc	-0.01338	-0.01079		
	(0.012)	(0.011)		
Inflation_GDPdefl_AnPc	0.00201	-0.00061	0.00194	0.00022
	(0.008)	(0.008)	(0.007)	(0.007)
LegalIndex	-0.37421***	-0.35335***	0.00327	0.00337
	(0.075)	(0.083)	(0.021)	(0.022)
L.NetInterestMargin			0.71139***	0.45830***
			-0.19	-0.131
GDPpc_nom		-0.00002	(0.00003)	-0.00004*
		(0.000)	(0.000)	(0.000)
Adults Saving %	0.07423***	0.08298***	0.04106**	0.03800**
	(0.015)	(0.026)	(0.016)	(0.017)
Adults Borrowing %	-0.03832*	-0.04824*	-0.05918**	-0.05533**
	(0.023)	(0.025)	(0.028)	(0.027)
SME Access Constraint	-0.05740***	-0.05500***		
	(0.013)	(0.015)		
Small firm credit line %			0.01552**	0.01791**
			(0.007)	(0.007)

Figure 3.1. Financial Evolution in SSA MICs

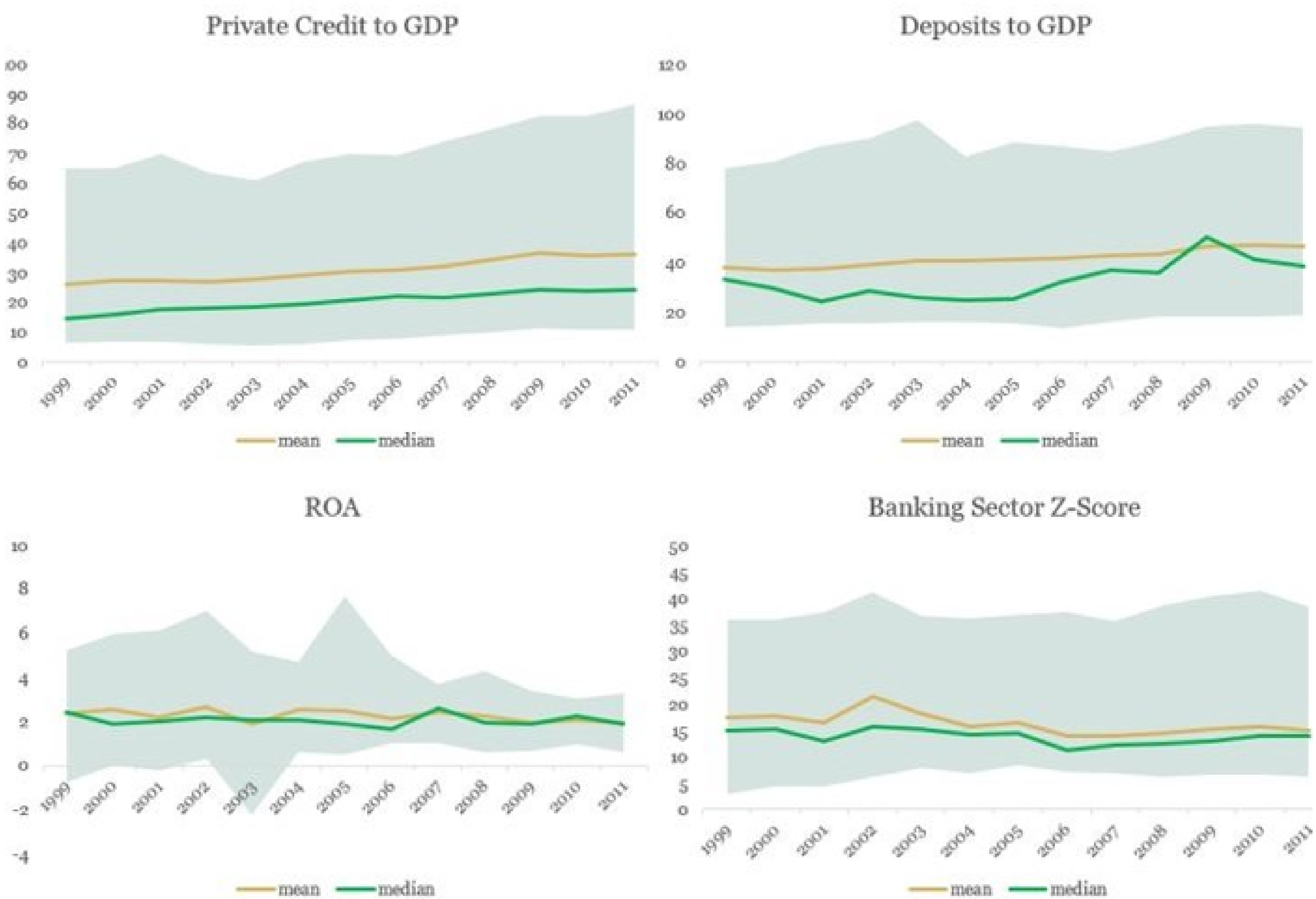


Figure 3.2. Benchmarking: Financial Stability relative to EMs in 2011

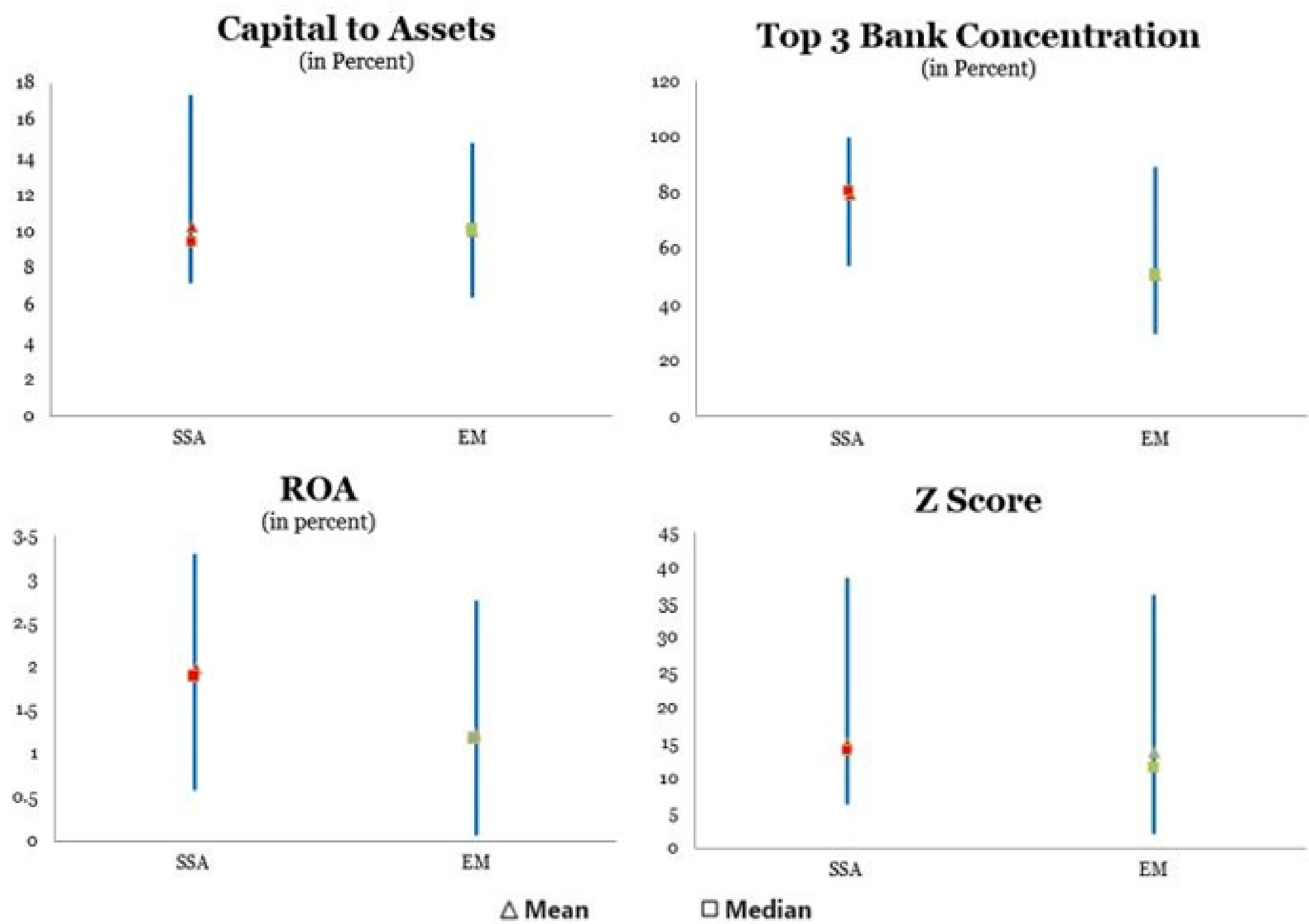


Figure 3.3. Benchmarking: Financial Access relative to EMs in 2011

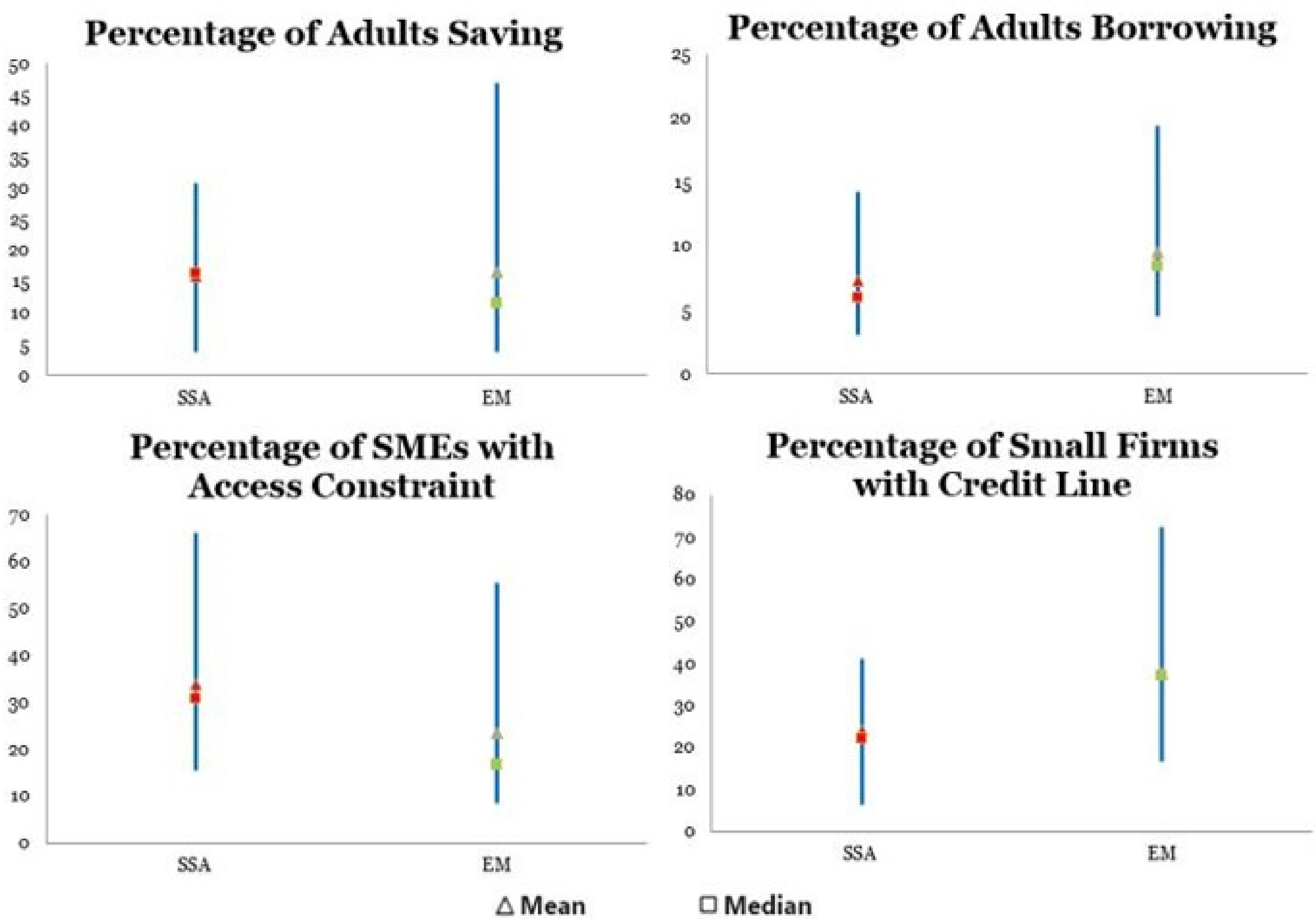
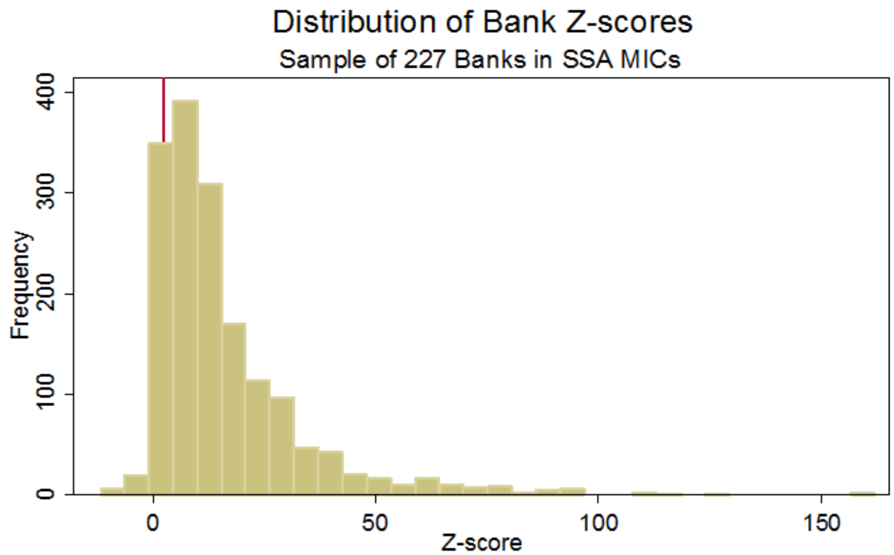


Figure 3.4. Distribution of Bank Z-scores, 1998-2013



The 10th percentile of individual bank Z-scores=2.424325 and is indicated by the red line

Source: Bankscope

Figure 3.5. Distribution of ln(Z-score) across SSA MICs, 2011

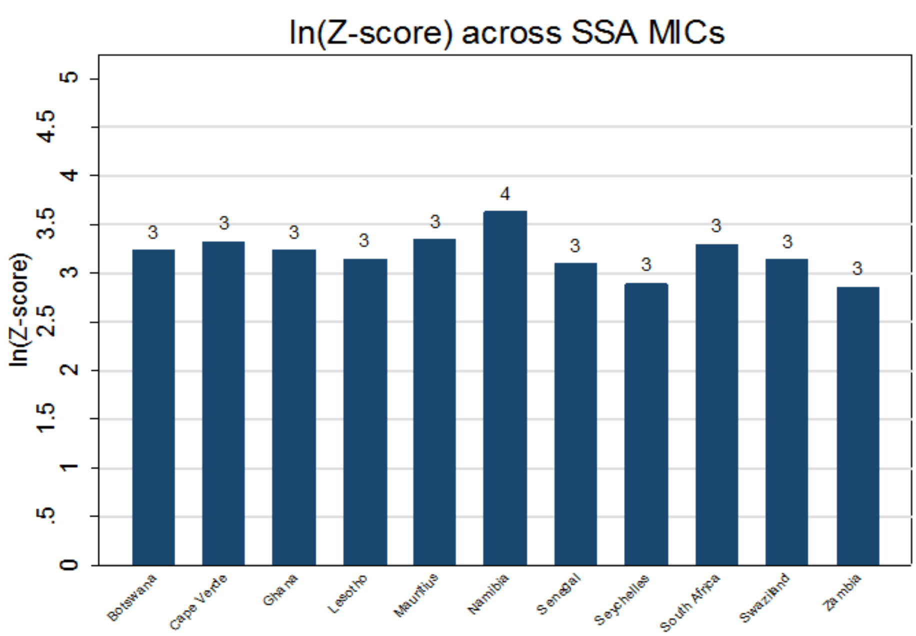


Figure 3.6. Graph of Non-linear Spline Variables: Size

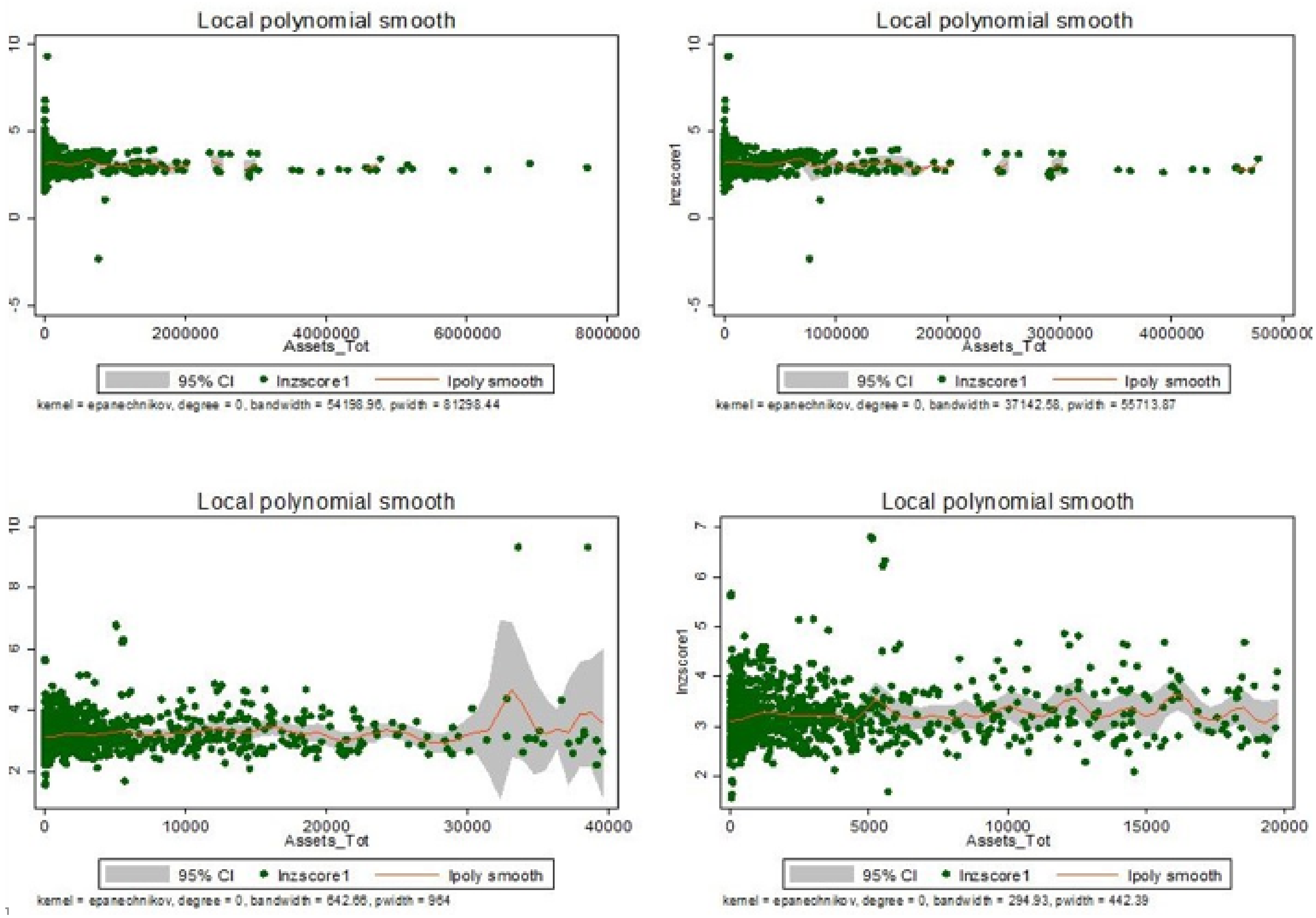
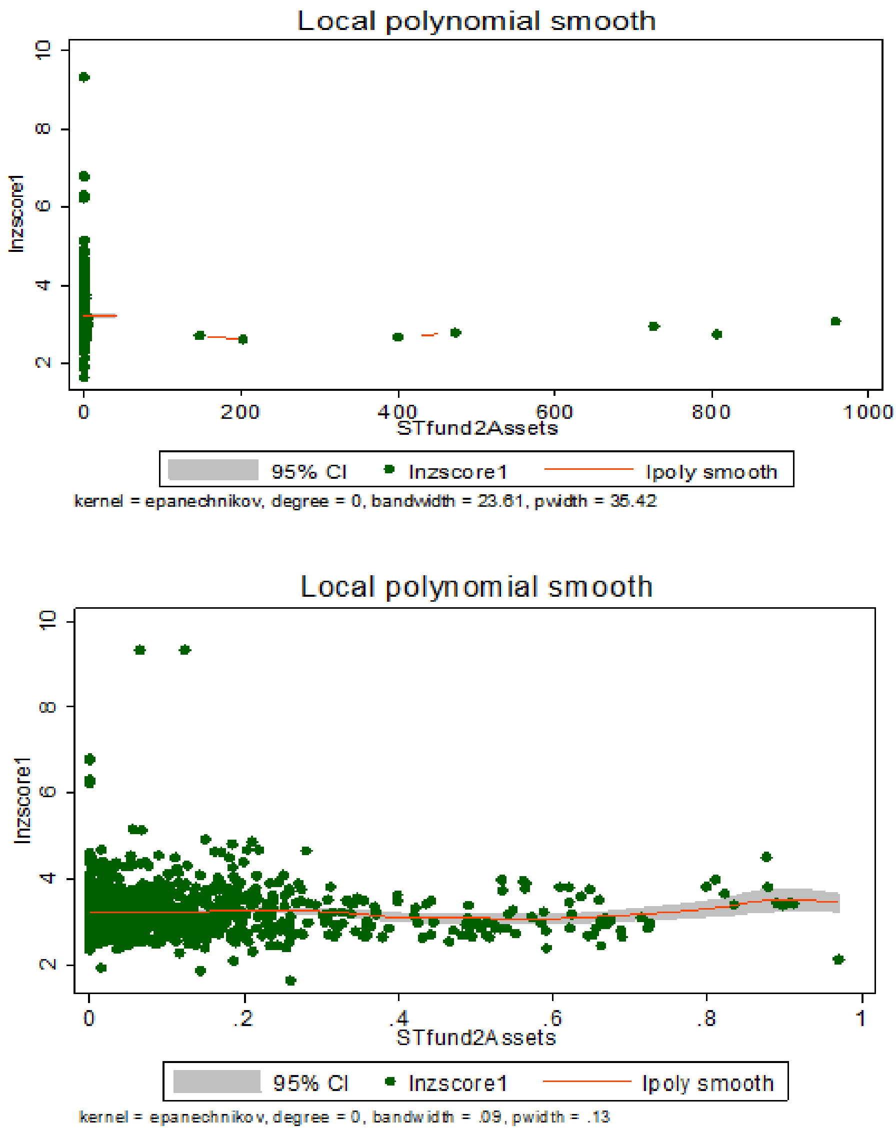


Figure 3.7. Graph of Non-linear Spline Variables: ST Funding to Assets



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