Harmful Pro-Competitive Effects of Trade in Presence of Credit Market Frictions*

Reto Foellmi, University of St. Gallen†

Manuel Oechslin, University of Lucerne‡

April 24, 2015

Abstract

We explore the consequences of international trade in an economy that encompasses technology choice and an endogenous distribution of mark-ups due to credit market frictions. We show that in such an environment a gradual opening of trade may – but not necessarily must – have a negative impact on productivity and overall output. The reason is that the pro-competitive effects of trade reduce mark-ups and hence make access to credit more difficult for smaller firms (an implication we substantiate using firm-level data from Latin America). As a result, smaller firms – while not driven out of the market – may be forced to switch to less productive technologies.

JEL classification: O11, F13, O16

Keywords: International trade, credit market frictions, productivity, polarization

*Support from the NCCR Trade Regulation and the Sinergia programme "Inequality and Trade" is acknowledged. An earlier version of this paper circulated under the title "Globalization and Productivity in the Developing World".

†University of St. Gallen, Department of Economics, SIAW, Bodanstrasse 8, CH-9000 St. Gallen, Switzerland; phone: +41 71 224 22 69, fax: +41 71 224 22 98, email: reto.foellmi@unisg.ch.

‡University of Lucerne, Department of Economics, P.O. Box 4466, 6002 Lucerne, Switzerland; phone: +41 41 229 57 22; email: manuel.oechslin@unilu.ch. CentER, Tilburg University, The Netherlands.

1 Introduction

How and through what channels does international trade affect productivity and overall output in an economy? The recent literature emphasizes several beneficial pro-competitive effects of trade: Stiffer competition is predicted to boost economic performance by reallocating production factors from less to more productive firms (e.g., Bernard et al., 2003; Melitz, 2003; Melitz and Ottaviano, 2008) or by improving within-firm efficiency as companies are forced to trim their fat (Pavcnik, 2002) or to upgrade technology (e.g., Lileeva and Trefler, 2010; Bustos, 2011). This paper, by contrast, identifies channels through which intensified foreign competition may have negative consequences for productivity and overall output. These channels are closely connected to the presence of significant credit market frictions.

We explore the impact of trade in a setup where firms have some degree of monopoly power and loan repayment is imperfectly enforceable. Imperfect enforceability implies that an entrepreneur's borrowing capacity depends on her private wealth. Less affluent entrepreneurs are therefore forced to run smaller firms – and hence charge higher prices and mark-ups. Greater exposure to trade, however, is bound to reduce these mark-ups: Competition from abroad reduces the maximum prices smaller firms can charge; moreover, there is a rise in the cost of borrowing since larger firms increase capital demand to take advantage of new export opportunities. Lower mark-ups, in turn, reduce the borrowing capacity of less affluent firm owners – which means that they may no longer be able to make the investments required to operate the high-productivity (i.e., state-of-the-art) technology.

The magnitude and consequences of this reduction in the access to credit depend on the degree to which a country integrates into the world economy. A steep fall in trade barriers has an unambiguously positive effect on economic performances as the dispersion of goods prices falls and low-productivity firms are driven out of the market. A smaller reduction, however, may actually hurt the economy through two different channels, both of which closely related to the credit market friction. First, there is a *polarization effect*. A gradual reduction of trade barriers reduces the maximum amount smaller firms can borrow and invest. As a result, some of these firms are forced to switch to less productive (i.e., "traditional") technologies. But because trade is not yet frictionless, even these firms are not forced to leave the market – which means that average productivity may fall. So a partial opening up reinforces the polar structure of the economy, i.e., the coexistence of small low-productivity firms and efficient large-scale companies. Second, we identify a *replacement effect*. The integration-induced fall in the borrowing capacity – and hence the output – of smaller firms requires the economy to import larger quantities and hence to spend more resources on trade-related costs (e.g., transportation costs). Put differently, an intermediate fall in trade barriers leads to a "costly" partial replacement of domestically-produced supplies with imports. This replacement effect is particularly strong in the neighborhood of the autarky equilibrium, i.e., if a fall in trade barriers pushes the economy from an equilibrium without trade to one with some trade. At this point, the replacement effect necessarily dominates the positive effect of trade (which is operating through a reduction in price dispersion). Our quantitative analysis suggests that in the case of a gradual reduction in trade barriers the negative pro-competitive effects of trade (i.e., the polarization effect and the replacement effect) may significantly outweigh the positive effect associated with stiffer competition.

So far, there has been little empirical research on how a fall in trade barriers affects the ability of small firms to obtain external financing. The present paper offers some suggestive evidence in this regard. Although intensified foreign competition may also be expected to influence firms' access to finance in high-income countries, we focus on evidence from developing or emerging economies because of the prevalence of credit market frictions in these places. More specifically, we rely on a firm-level dataset that has recently been put together by Foellmi, Legge, and Tiemann (2015). The dataset, which has a two-period panel structure, covers seven Latin American countries and contains 544 manufacturing firms, surveyed in the years 2006 and 2010. The empirical findings are supportive of the key mechanism we describe in our framework: A reduction in tariff protection makes small and medium-sized businesses much more likely to respond "access to finance" when asked which element of the current business environment represents the biggest obstacle; among large firms, on the other hand, such an effect of tariff reductions cannot be identified.

Considering that credit market frictions are particularly severe in low-income countries, our model can also offer a coherent perspective on a growing body of empirical evidence on the effects of trade in the developing world. At the most aggregate level, the predicted ambiguity regarding the impact on overall output is consistent with a voluminous cross-country literature on trade policy and economic performance. This literature fails to identify a robust link between policies related to openness and economic growth, particularly among developing countries.[1] Moreover, the model features a genuine mechanism which makes the richest segment of society benefit disproportionally – and hence may explain why liberalizing trade went hand in hand

[1] There are a number of studies (e.g., Dorwick and Golley; 2004; DeJong and Ripoll, 2006) that identify a positive impact of openness on growth in more advanced economies but no clear effect in developing countries. Other papers find that – in developing countries – more openness is harmful for growth (Yanikkaya, 2003); others again suggest exactly the opposite effect (e.g., Warner, 2003). See Kehoe and Ruhl (2010) for an overview.

with surging top income shares in Argentina (Atkinson et al., 2011, Figure 11), India (Banerjee and Piketty, 2005, Figure 4), and other developing countries. At a more disaggregate level, the model accounts for recent observations regarding misallocation and firm productivity. Among them are findings from India which suggest that allocative efficiency deteriorated (Hsieh and Klenow, 2009) and that the pro-competitive effects of trade did not promote average firm productivity in a broad sample of formal sector firms (Nataraj, 2011).[2]

In modeling credit market frictions, we follow an approach taken by Foellmi and Oechslin (2010). Relying on a setup with a simple linear technology, Foellmi and Oechslin (2010) explore the impact of trade liberalization on the income distribution by comparing the autarky to the free-trade equilibrium. This paper, by contrast, presents a model with technology choice and focuses on the behavior of aggregate productivity and output as trade barriers fall continuously from prohibitive levels to zero; it further offers a quantitative analysis of the effects of gradual declines in trade barriers. The paper at hand is thus closely related to the literature on trade and heterogeneous firms. Yet, by emphasizing the role of credit market frictions, our theory deviates from the standard classes of models (i.e., Bernard et al., 2003; Melitz, 2003; Melitz and Ottaviano, 2008; Bustos, 2011) and, as a result, suggests an ambiguous relationship between international trade and economic performance.

We further add to a growing literature on international trade and finance. Papers in this literature explore how financial frictions constrain export-oriented firms, thereby distorting aggregate export flows (e.g., Amiti and Weinstein, 2011; Feenstra et al., 2011; Manova, 2013; Besedeš et al., 2014) and impeding technology upgrading (e.g., Peters and Schnitzer, 2012). Relying on a general equilibrium framework, our paper is more interested in how trade affects mark-ups and, through this channel, the borrowing conditions of smaller (and not necessarily export-oriented) firms.[3] By focusing on how trade affects the distribution of mark-ups, our analysis also connects with recent work by Epifani and Gancia (2011) who show that the pro-competitive effects of trade can reduce welfare when they increase the mark-up dispersion. This paper, by contrast, shows that – when there are credit market imperfections – international

[2] Focusing on big formal-sector firms in India, Topalova and Khandelwal (2011) do find a positive pro-competitive effect on average firm productivity. Yet, this effect is small: A 10-percentage-point fall in output tariffs lifts productivity by just 0.32%. Moreover, results by Nataraj (2011) suggest that this effect is limited to big companies, as it cannot be detected in a representative sample of formal-sector firms. However, both papers find that a fall in input tariffs boosts productivity (as firms gain access to cheaper inputs).

[3] Earlier papers which rely on general-equilibrium models include Banerjee and Newman (2004), Matsuyama (2005), and Antràs and Caballero (2009). These papers elaborate variants of the Ricardo-Viner model or in the case of Antràs and Caballero (2009) the Heckscher-Ohlin model. However, these papers do not address how the pro-competitive effects of trade affect mark-ups and thus access to credit and technology choices.

trade may reduce welfare even if it leads to a more even distribution of mark-ups.

More broadly, our analysis is connected to a growing literature that explores how distortions and factor market imperfections lead to resource misallocation and hence compromise total factor productivity in low-income countries. Papers by, for instance, Banerjee and Newman (1993), Matsuyama (2000), Banerjee and Duflo (2005), or Song et al. (2011) also examine the role of credit market imperfections, partly in connection with wealth or income inequality. Yet, these papers do not address whether greater exposure to international trade affects the resource allocation in a positive or a negative way – which is the prime focus here.[4]

The rest of this paper is organized as follows. The next section presents some new evidence on trade liberalization and access to finance. Section 3 develops and solves the closed-economy model. In Section 4, we explore the effects of opening up to international trade. We proceed in two steps. First, focusing on an intermediate-openness case, we describe the different channels by which trade affects economic performance. Second, we systematically analyze the adjustments associated with a continuous fall in trade costs from prohibitive levels to zero and discuss some quantitative implications. Section 5, finally, concludes.

2 Evidence on Trade and Access to Finance

We use a new firm-level dataset compiled by Foellmi, Legge, and Tiemann (2015) to develop motivating evidence on trade liberalization and access to finance. The dataset combines two data sources, the World Bank's Enterprise Surveys (WBES) and the World Integrated Trade Solution (WITS) database. WBES provides firm-level survey data, including information on access to finance, firm size, and industry classification. WITS contains information on tariff rates at the four-digit ISIC level, allowing us to infer the degree of tariff protection enjoyed by each firm. To ensure comparability across countries, the dataset focuses on Latin America where firms were interviewed with standardized questionnaires. It covers all Latin American countries in which firms were interviewed twice (in 2006 and 2010) and for which tariff rates were available: Argentina, Bolivia, Chile, Colombia, Paraguay, Peru, and Uruguay. Only manufacturing firms are included, of which 880 were interviewed in both years. Among these 880 firms, 320 changed their industry classification between 2006 and 2010, implying that any difference in tariff protection between 2006 and 2010 is affected by the firm's own decision to switch industries. Excluding these firms leaves us with a small but clean two-period panel

[4] We share this prime focus with other recent work by, e.g., Egger and Kreickemeier (2009), Kambourov (2009), Helpman et al. (2010), Felbermayr et al. (2011), or McMillan and Rodrik (2011). However, all of these contributions consider the role of labor market frictions.

dataset that contains 560 manufacturing firms from seven Latin American countries. Tariff information is lacking in 16 cases, however, so that our sample consists of 544 firms.

The main variable of interest is a dummy variable, called *FIN_CONS*, that takes on the value 1 if a firm responds "access to finance" when asked which element of the business environment represents the biggest obstacle ("access to finance" is one answer in a list of 15 possible answers). We are interested in two related questions. First, did the share of firms responding "access to finance" increase by more in the subset of firms operating in industries that experienced a substantial tariff reduction? Second, is the negative effect (if any) of such tariff reductions on access to finance stronger among smaller firms than among larger firms? Throughout, we consider tariff cuts of 0.5 percentage points or more to be substantial.[5] We further consider firms with less than 100 employees in the year 2006 to be "smaller firms" (while firms with 100 or more employees in 2006 are treated as "larger firms").

Table 1 here

Table 1 presents the main empirical pattern. The table reports results based on the full firm sample (Columns 1 and 2); on the subset of smaller firms (Columns 3 and 4); and on the subset of larger firms (Columns 5 and 6). To answer the first of the above questions, we look at the results for the full sample. We observe that – indeed – the share of firms identifying access to finance as their major problem rose markedly (but not significantly) in the subset of firms that experienced a substantial decrease in tariffs (Column 1); on the other hand, this share fell slightly in the subset of firms that did not experience such a decrease (Column 2). This uneven development is also reflected in the two difference-in-difference (DiD) estimates. Our DiD model includes country (and industry) dummies, thereby allowing for country- (and industry-) specific trends in the access to finance.[6] According to these estimates, a substantial tariff reduction leads to a significant increase in the probability that a firm identifies access to finance as the biggest obstacle. The magnitude of the impact is in the range of 11 to 13

[5] Average tariff protection in the initial year, 2006, was about 10 percent. Tariffs fell on average by 4 percentage points in industries which experienced a substantial reduction. Note further that the results presented below are robust to changes in the definition of what amounts to a "substantial reduction". In particular, setting the threshold at either -0.25 or -0.75 percentage points leads to very similar results.

Tariffs changes were heterogenous across countries in that period. The major reductions occurred in Peru and Uruguay. Peru signed in 2006 the US-Peru Trade Promotion Agreement (PTPA) which eliminated (or phased out over ten years) most existing tariffs between the two trade partners. Similarly, Uruguay signed several bilateral trade agreements with the US between 2006 and 2008.

[6] The DiD results are based on an OLS estimate of $\Delta FIN\_CONS_i = \beta_0 + \beta_1 RT_i + \boldsymbol{\gamma}'\mathbf{C}_i + \boldsymbol{\delta}'\mathbf{I}_i + \epsilon_i$, where RT_i is a dummy that takes on the value 1 if firm i was subject to a substantial tariff reduction; $\mathbf{C}_i$ is a vector of country dummies; $\mathbf{I}_i$ is a vector of industry dummies (at the 2-digit level); and ϵ_i represents the error term.

percentage points, depending on the DiD model used. As for the second question, comparing Columns 3 and 4 (smaller firms) to 5 and 6 (larger firms) confirms that the results obtained in the full firm sample are driven by the subset of smaller firms: While the estimated effect of a substantial tariff reduction is even bigger among smaller firms, we do not find such an effect at all in the subset of larger firms. Therefore, overall, Table 1 provides evidence in support of the relevance of a key mechanism in the model to be developed below: A reduction in tariff protection makes it harder for smaller firms, but not for larger ones, to obtain credit.

3 The Closed Economy

3.1 Endowments, Technologies, and Preferences

Assumptions. We consider a static economy that is populated by a continuum of (potential) entrepreneurs. The population size is normalized to 1. The entrepreneurs are heterogeneous with respect to their initial capital endowment $\omega_i, i \in [0,1]$, and their production possibilities. The capital endowments are distributed according to the distribution function $G(\omega)$ which gives the measure of the population with an endowment below ω. We further assume that $g(\omega)$, which refers to the density function, is positive over the entire positive range. The aggregate capital endowment, $\int_0^\infty \omega dG(\omega)$, will be denoted by K.

Each entrepreneur is a monopoly supplier of a single good. Unlike in a standard monopolistic competition model, we consider a fixed number of established entrepreneurs who decide on how much of their good to produce. This setup captures the short run (Melitz and Ottaviano, 2008) or may reflect a situation in which further entry is associated with prohibitive fixed costs.[7] All goods are produced with a simple technology that requires physical capital as the only input into production. Following much of the related literature on the role of credit market imperfections (e.g., Galor and Zeira, 1993; Matsuyama, 2000; Banerjee and Moll, 2010), this technology is characterized by a simple non-convexity. In particular, its productivity is relatively low if the level of investment falls short of a critical threshold:

$$y_i = \begin{cases} bk_i & : \quad k_i < \kappa \\ ak_i & : \quad k_i \geq \kappa \end{cases}, \quad b < a, \tag{1}$$

where y_i and k_i denote, respectively, output and capital and κ refers to the critical scale of investment. So, unlike in Bustos (2011), a higher productivity level does not require the payment

[7]Such fixed costs of entry may include the cost of complying with entry regulations, which tend to be particularly high in low-income countries (Djankov et al., 2002).

of a fixed cost. In what follows, we say that an entrepreneur operates the "low-productivity technology" if she invests less than the κ-threshold; similarly, we say that an entrepreneur operates the "high-productivity technology" if the investment exceeds this threshold.

The assumptions of market power and non-convexities play an important role in our model. They will allow us to capture the idea that opening up, by exposing firms to tougher competition, may hurt productivity in presence of credit market frictions (introduced below).

The entrepreneurs' utility function is assumed to be of the familiar CES-form,

$$U = \left(\int_0^1 c_j^{(\sigma-1)/\sigma} dj \right)^{\frac{\sigma}{\sigma-1}}, \tag{2}$$

where c_j denotes consumption of good j and $\sigma > 1$ represents the elasticity of substitution between any two goods. Each entrepreneur i maximizes objective function (2) subject to

$$\int_0^1 p_j c_j dj = m(\omega_i), \tag{3}$$

where p_j is the price of good j and $m(\omega_i)$ refers to entrepreneur i's nominal income (which, in turn, will depend on the initial capital endowment, as is discussed further below).

Finally, for tractability purposes, we impose a parameter restriction which puts an upper bound on the critical scale of investment:

$$\kappa < K(b/a)^{\sigma-1}. \tag{R1}$$

Implications. Under these conditions, entrepreneur i's demand for good j is given by

$$c_j(y(\omega_i)) = \left(\frac{p_j}{P}\right)^{-\sigma} \frac{m(\omega_i)}{P}, \tag{4}$$

where $P \equiv (\int_0^1 p_j{}^{1-\sigma} dj)^{1/(1-\sigma)}$ denotes the CES price index. In a goods market equilibrium, aggregate demand for good j must be equal to the supply of good j, y_j. Taking this into account, we can express the real price of good j as a function of y_j and Y/P,

$$\frac{p_j}{P} = \frac{p(y_j)}{P} \equiv \left(\frac{Y}{P}\right)^{\frac{1}{\sigma}} y_j^{-1/\sigma}, \tag{5}$$

where $Y \equiv \int_0^1 p(y_j) y_j dj$ denotes the economy-wide nominal output and the ratio Y/P refers to the aggregate real output. Notice further that, in a goods market equilibrium, the real price of a good is strictly decreasing in the quantity produced. The reason is simple: Since the marginal utility from consuming any given good falls in the quantity consumed, the only way to make domestic consumers buy larger quantities is to lower the price.

Later on, it will be helpful to have an expression for the aggregate real output (or, equivalently, for the aggregate real income) that depends only on the distribution of firm outputs. Using (5) in the definition of Y, we obtain

$$\frac{Y}{P} = \left(\int_0^1 y_j^{(\sigma-1)/\sigma} dj \right)^{\frac{\sigma}{\sigma-1}} = \frac{M}{P}, \tag{6}$$

where $M \equiv \int_0^1 m(\omega_i) di$ denotes the aggregate nominal income.

3.2 The Credit Market

Assumptions. Entrepreneurs may borrow and lend in an economy-wide credit market. Unlike the goods market, the credit market is competitive in the sense that both lenders and borrowers take the equilibrium borrowing rate as given. However, the credit market is imperfect in the sense that borrowing at the equilibrium rate may be limited. As in Foellmi and Oechslin (2010), such credit-rationing may arise from imperfect enforcement of credit contracts. More specifically, we assume that borrower i can avoid repayment altogether by incurring a cost which is taken to be a fraction $\lambda \in (0, 1]$ of the current firm revenue, $p(y_i)y_i$.

The parameter λ mirrors how well the credit market works. A value close to one represents a near-perfect credit market while a value near zero means that the credit market functions poorly. Intuitively, in the latter case, lenders are not well protected since the borrowers can "cheaply" default on their payment obligations – which invites ex post moral hazard. As a result, lenders are reluctant to provide external finance.

Poor creditor protection is a particularly important phenomenon in many developing countries. For example, it is well documented that – throughout the developing world – insufficient collateral laws or unreliable judiciaries often make it extremely hard to enforce credit contracts in a court (see, e.g., Banerjee and Duflo, 2005; 2010).

Implications. Taking the possibility of ex post moral hazard into account, a lender will give credit only up to the point where the borrower just has the incentive to pay back. In formal terms, this means that the amount of credit cannot exceed $\lambda p(y_i)y_i/\rho_i$, where ρ_i denotes the interest rate borrower i faces. Note further that – since borrowers always repay and because there are no individual-specific risks associated with entrepreneurship – the borrowing rate must be the same for all agents ($\rho_i = \rho$). Using this information, and accounting for (1), we find that borrower i does not default on the the credit contract ex post if

$$\lambda p(y_i)y_i/\rho \geq \begin{cases} y_i/b - \omega_i & : \quad y_i < a\kappa \\ y_i/a - \omega_i & : \quad y_i \geq a\kappa \end{cases}, \tag{7}$$

where the right-hand side of (7) gives the size of the credit.

We now derive how the maximum amount of borrowing, and hence the maximum output, depends on the initial wealth endowment, ω.[8] To do so, suppose that there is a wealth level $\omega_\kappa < \kappa$ which permits borrowing exactly the amount required to meet the critical investment size κ. Taking (5) and (7) into account, this threshold level is defined by

$$\omega_\kappa + \lambda x \left(a\kappa\right)^{(\sigma-1)/\sigma} = \kappa, \tag{8}$$

where

$$x \equiv P^{(\sigma-1)/\sigma} Y^{1/\sigma}/\rho = (Y/P)^{1/\sigma}/(\rho/P). \tag{9}$$

With these definitions (and expressions 5 and 7) in mind, it is immediately clear that the maximum firm output is implicitly determined by

$$\overline{y} = \begin{cases} b\left(\omega + \lambda x \overline{y}^{(\sigma-1)/\sigma}\right) & : \quad \omega < \omega_\kappa \\ a\left(\omega + \lambda x \overline{y}^{(\sigma-1)/\sigma}\right) & : \quad \omega \geq \omega_\kappa \end{cases} \tag{10}$$

and hence depends on the initial wealth endowment. It is the purpose of the following lemma to clarify the relationship between $\overline{y}$ and ω.

Lemma 1 *A firm's maximum output, $\overline{y}(\omega)$, is a strictly increasing function of the initial capital endowment, ω.*

Proof. See Appendix. ■

The maximum firm output increases in ω for two different reasons. First, and most directly, an increase in ω means that the entrepreneur commands more own resources which can be invested. Second, there is an indirect effect operating through the credit market: An increase in ω allows for higher borrowing since the entrepreneur has more "skin in the game" (Banerjee and Duflo, 2010). Figure 1 shows a graphical illustration of $\overline{y}(\omega)$.

Figure 1 here

Besides the positive slope, the figure highlights two additional properties of the $\overline{y}(\omega)$-function. First, the function is locally concave. This mirrors the fact that the marginal

[8] Since the initial wealth is the only individual-specific factor that determines maximum borrowing, the index for individuals will be dropped in the rest of this section.

return on investment falls in the level of investment; thus, the positive impact of an additional endowment unit on the borrowing capacity must decrease. Second, there is a discontinuity at ω_κ since, at that point, an entrepreneur is able to switch to the more productive technology.

3.3 Output Levels

We now discuss how individual firm outputs depend on capital endowments, holding constant the aggregate variables Y/P and ρ/P (and hence x). Our discussion presumes

$$x \geq \frac{1}{a}\frac{\sigma}{\sigma-1}(a\kappa)^{1/\sigma}, \tag{11}$$

which will actually turn out to be true in equilibrium (see Proposition 1).

$\omega \geq \omega_\kappa$. We start by looking at entrepreneurs who are able to use the more productive technology. Resources permitting, these entrepreneurs increase output up to the point where the marginal revenue, $((\sigma-1)/\sigma)P^{(\sigma-1)/\sigma}Y^{1/\sigma}y^{-1/\sigma}$, equals the marginal cost, ρ/a. We denote this profit-maximizing output level by $\widetilde{y}$ and we use $\widetilde{\omega}$ to denote the wealth level which puts an agent exactly in a position to produce $\widetilde{y}$. Using these definitions, we have

$$\widetilde{y} = \left(ax\frac{\sigma-1}{\sigma}\right)^{\sigma} \quad \text{and} \quad \widetilde{\omega} = \left(1-\lambda\frac{\sigma}{\sigma-1}\right)\frac{\widetilde{y}}{a}, \tag{12}$$

where $\widetilde{y}/a \geq \kappa$ due to (11).

Two points should be noted here. First, because of Lemma 1 and $\widetilde{y} \geq a\kappa$, we have $\widetilde{\omega} \geq \omega_\kappa$. Second, as can be seen from the second expression in (12), $\lambda < (\sigma-1)/\sigma$ is sufficient for having a group of credit-constrained entrepreneurs, i.e., entrepreneurs who have too little access to credit to produce at the profit-maximizing output level. On the other hand, if $\lambda \geq (\sigma-1)/\sigma$, even entrepreneurs with a zero wealth endowment can operate at the profit-maximizing scale. Why? The smaller the elasticity of substitution, the higher is the constant mark-up $\sigma/(\sigma-1)$ over marginal costs. So, if σ is small, even poor agents are able to generate revenues which are large relative to the payment obligation. This means that only a very low λ may induce a borrower to default ex post. Put differently, the credit market imperfection is binding for some entrepreneurs only if it is "more substantial" than the imperfection in the product market.

The following lemma is an immediate corollary of the above discussion:

Lemma 2 *Suppose $\lambda < (\sigma-1)/\sigma$. Then, entrepreneurs (i) with $\omega \in [\omega_\kappa, \widetilde{\omega})$ produce $\overline{y}(\omega) < \widetilde{y}$; (ii) with $\omega \in [\widetilde{\omega}, \infty)$ produce $\widetilde{y}$. Otherwise, if $\lambda \geq (\sigma-1)/\sigma$, all entrepreneurs produce $\widetilde{y}$.*

Proof. See Appendix. ■

$\omega < \omega_\kappa$. We now focus on the investment behavior of less affluent entrepreneurs, i.e., agents with a capital endowment below ω_κ (which does not allow for the use of the high-productivity technology). As established above, such entrepreneurs can only exist if $\lambda < (\sigma-1)/\sigma$.

Lemma 3 *Suppose $\lambda < (\sigma-1)/\sigma$. Then, entrepreneurs with a wealth endowment below ω_κ produce $\overline{y}(\omega)$.*

Proof. See Appendix. ■

Putting things together. An immediate implication of Lemmas 2 and 3 is that the equilibrium individual firm outputs are given by

$$y(\omega) = \begin{cases} \overline{y}(\omega) & : \quad \omega < \widetilde{\omega} \\ \widetilde{y} & : \quad \omega \geq \widetilde{\omega} \end{cases}, \tag{13}$$

where $\overline{y}(\omega)$ is implicitly determined by (10) and $\widetilde{y}$ is given in (12). Note that the case $\omega < \widetilde{\omega}$ is only relevant if the parameter restriction $\lambda < (\sigma-1)/\sigma$ holds (and hence $\widetilde{\omega} > 0$). Assuming that the restriction does hold, Figure 2 gives a graphical illustration of (13). The figure shows two possible situations. In panel *a.*, we have $\omega_\kappa > 0$ so that a positive mass of entrepreneurs are forced to use the less productive technology. Panel *b.* shows a situation where $\omega_\kappa \leq 0$ so that all entrepreneurs have access to the more productive technology.

Figure 2 here

The distribution of firm outputs is mirrored in the distribution of output prices. Since each firm faces a downward-sloping demand curve (equation 5), smaller firms charge higher prices – despite the fact that each good enters the utility function symmetrically. Only if there is no credit rationing do output levels across firms fully equalize so that all prices are the same.

3.4 The Equilibrium under Autarky

When characterizing the use of technology and individual firm outputs, we kept constant aggregate real output and the real interest rate (and hence the ratio $x = (Y/P)^{1/\sigma}/(\rho/P)$). We now establish that, in fact, both Y/P and ρ/P are uniquely determined in the macroeconomic equilibrium. To do so, note that we can write aggregate gross capital demand (i.e., the sum of all physical capital investments by firms) as a function of x,

$$K^D(x) = \int_0^{\omega_\kappa} \frac{\overline{y}(\omega;x)}{b} dG(\omega) + \int_{\omega_\kappa}^{\widetilde{\omega}} \frac{\overline{y}(\omega;x)}{a} dG(\omega) + \int_{\widetilde{\omega}}^{\infty} \frac{\widetilde{y}(x)}{a} dG(\omega), \tag{14}$$

where aggregate capital supply, $K = \int_0^\infty \omega dG(\omega)$, is exogenous and inelastic.

Proposition 1 *There exists a unique macroeconomic equilibrium (i.e., real output, Y/P, and the real interest rate, ρ/P, are uniquely pinned down). If $\lambda < (\sigma - 1)/\sigma$, a positive mass of entrepreneurs is credit-constrained (and the poorest among them may be forced to use the low-productivity technology). Otherwise, if $\lambda \geq (\sigma - 1)/\sigma$, no one is credit-constrained.*

Proof. See Appendix. ■

Figure 3 here

Figure 3 shows K^D as a function of x (for the case $\lambda < (\sigma - 1)/\sigma$). The figure also highlights that condition (11), on which both Lemma 2 and 3 rely, is indeed satisfied.[9]

Finally, note that – if the credit market friction is sufficiently severe – the properties of this equilibrium are consistent with a large body of firm-level evidence from developing countries. In particular, we have a coexistence of (i) more and less advanced technologies; (ii) high and low marginal (revenue) products of capital (see Banerjee and Duflo, 2005, for empirical evidence). Moreover, there is substantial variation in the revenue productivities (TFPR) across firms, as is the case in China and India (see Hsieh and Klenow, 2009, for empirical evidence).

4 Integrating into the World Economy

We now explore the consequences of opening up to trade. After introducing the assumptions (Subsection 4.1), we focus first on an equilibrium that arises if trade costs are in an intermediate range (4.2). We do so because this equilibrium is very suitable for illustrating the channels by which trade affects the economy. We then move on to a full characterization of how the economy responds as trade costs fall from prohibitive levels to zero (4.3). Finally, we examine the robustness of our results to some natural modifications in the assumptions (4.4).

4.1 Assumptions

The home economy – which may represent a developing country – will be called the "South". The rest of the world (i.e., the South' trading partner) is referred to as the "North" and represents an advanced economy. So far, the trade barriers have been assumed to be sufficiently high to prevent trade between South and North. This section focuses on a situation in which trade between the two regions may occur. Yet, North and South are less than perfectly integrated

[9] If $\lambda \geq (\sigma - 1)/\sigma$, we have $K^D(x) = (x(\sigma - 1)/\sigma)^\sigma a^{\sigma-1}$, and it can be easily checked that $K^D(x) = K$ defines a unique x (with $Y/P = aK$ and $\rho/P = a(\sigma - 1)/\sigma$).

due to the existence of trade costs (which may be composed of tariffs and transport costs). We rely on the usual "iceberg" formulation and assume that $\tau \geq 1$ units of a good have to be shipped in order for one unit to arrive at the destination. Moreover, we continue to assume that the southern and the northern credit markets are not integrated.

The North differs from the South in that its markets function perfectly. In particular, the northern credit market is frictionless, implying that there are no credit constraints. Moreover, unlike in a standard trade model with monopolistic competition, the North has perfectly competitive goods markets in the sense that each good is produced by a large number of price-taking firms. Regarding access to technology and preferences, there are no differences between the two regions (i.e., technology and preferences are also represented by equations 1 and 2), and the North is assumed to produce the same spectrum of goods as the South does.[10] The assumptions regarding northern markets and goods allow us to capture in a parsimonious way the notion that the South, being a relatively small and initially protected economy, will face an increase in the degree of competitiveness when opening up to a big (world) market. More specifically, a gradual fall in trade barriers exposes each southern firm to competition from a large number of suppliers that offer a very similar – or, in fact, identical – good; as a result, the mark-ups that can maximally be charged by southern firms will fall as well.

Given our assumptions about markets and technologies, we can immediately conclude that all northern firms operate the high-productivity technology and charge a uniform price – which, in turn, is equal to the marginal cost. In what follows, it is convenient to take the northern marginal cost as the numéraire. This choice of numéraire implies that all goods prices in the North are also equal to one.

4.2 An Equilibrium with Intermediate Trade Costs

Under the assumptions made above, it is clear that τ gives the (marginal) cost of producing one unit of a good in the North and selling it in the South. As a result, since the northern firms operate under perfect competition, the price of any good produced in the North and exported to the South is given by τ. This, in turn, implies that all southern producers face a northern competitive fringe and cannot set a price above τ.

[10] In Subsection 4.4, we consider alternative assumptions about the spectrum of goods produced in the North as well as about the structure of the northern goods markets.

4.2.1 Characterizing the Equilibrium

In what follows, we focus on an "intermediate" τ which makes a positive fraction of entrepreneurs – but not all of them – unable to set the price that would make domestic demand equal to the output produced by the firm. More specifically, we discuss an equilibrium where τ is such that (i) the price that would imply a domestic demand of $a\kappa$ units exceeds the upper bound τ; (ii) the profit-maximizing price charged by unconstrained entrepreneurs lies below the upper bound. In formal terms, we focus on

$$p(a\kappa) > \tau > p(\widetilde{y}), \tag{15}$$

where $p(y)$ and $\widetilde{y}$ are defined in (5) and (12), respectively.

Allowing for international trade leads to two formal adjustments. First, the fact that there is a binding upper bound on prices changes the relationship between the endowment and the maximum firm output. For price-constrained firms, the relationship is now given by

$$\overline{y}^I = \begin{cases} b\left(\omega + \lambda\tau\rho^{-1}\overline{y}^I\right) & : \quad 0 \leq \omega < \omega_\kappa^I \\ a\left(\omega + \lambda\tau\rho^{-1}\overline{y}^I\right) & : \quad \omega_\kappa^I \leq \omega < \omega_\tau^I \end{cases}, \tag{9'}$$

where ω_κ^I denotes the level which permits borrowing of exactly the amount required to meet the critical investment size κ; ω_τ^I refers to the threshold which allows an entrepreneur to produce a quantity of output that goes exactly together with an equilibrium price of τ.[11] A straightforward derivation of the two thresholds in (9') gives

$$\omega_\kappa^I = \left(1 - \frac{\lambda a\tau}{\rho}\right)\kappa \;\text{ and }\; \omega_\tau^I = \left(1 - \frac{\lambda a\tau}{\rho}\right)(Y/P)(\tau/P)^{-\sigma}/a. \tag{16}$$

The second formal change concerns the determination of the borrowing rate. Since we are looking at an equilibrium in which a positive mass of entrepreneurs is price-constrained, the economy imports goods from abroad. This, in turn, implies that there must be positive aggregate exports (because trade needs to be balanced in our static framework). The fact that the equilibrium involves exports allows us to explicitly pin down the borrowing rate. Since exporting one unit of an arbitrary good (which requires $\tau \cdot 1/a$ units of capital) generates an income of 1, ρ must be equal to a/τ. If ρ were higher, nobody would export since lending would generate a higher return; if ρ were lower, demand for capital would exceed supply since even the richest agents in the economy would seek credit in order to export as much as possible.

In the North, on the other hand, the borrowing rate, denoted by ρ^*, is equal to a: This follows immediately from taking the northern marginal cost ρ^*/a as numéraire. So, as long as

[11] For capital endowments equal to or bigger than ω_τ^I, the maximum output a firm can produce continues to be implicitly determined by $\overline{y}^I = a(\omega + \lambda x\left(\overline{y}^I\right)^{(\sigma-1)/\sigma})$.

long as $\tau > 1$, we have $\rho = a/\tau < \rho^* = a$. It is exactly this gap between the two borrowing rates that turns capital-rich southern firms into competitive exporters.[12] We put down these crucial results in the following lemma:

Lemma 4 *In an equilibrium with intermediate trade costs (equation 15), the southern borrowing rate ρ must be equal to a/τ. The northern borrowing rate ρ^* equals a and exceeds the southern borrowing rate for $\tau > 1$.*

Proof. In text. ■

We now work towards a description of the parameter constellations under which this equilibrium arises. The first step is to note that using $\rho = a/\tau$ in (16) yields

$$\omega_\kappa^I = \left(1 - \lambda\tau^2\right)\kappa \quad \text{and} \quad \omega_\tau^I = \left(1 - \lambda\tau^2\right)(Y/P)(\tau/P)^{-\sigma}/a.$$

Thus, for a positive mass of price-constrained entrepreneurs to exist, we need $\tau^2 < 1/\lambda$. Secondly, observe that condition (15) implies a lower bound on τ. Using both $\rho = a/\tau$ (Lemma 4) and the definition of $\widetilde{y}$ in expression (5) yields

$$p(\widetilde{y}) = \frac{1}{\tau}\frac{\sigma}{\sigma - 1}. \tag{17}$$

As a result, $\tau > p(\widetilde{y})$ is equivalent to $\tau^2 > (\sigma/(\sigma - 1))$. In sum, we must therefore have

$$\frac{\sigma}{\sigma - 1} < \tau^2 < \frac{1}{\lambda}. \tag{R2}$$

Finally, we want to make sure that entrepreneurs with $\omega < \omega_\kappa^I$ do indeed run a firm (instead of becoming lenders). To get the required condition, note that each capital unit invested in a low-productivity firm generates a return of τb while lending is associated with a return of a/τ. We assume that the former exceeds the latter:

$$a/b < \tau^2. \tag{R3}$$

4.2.2 Establishing the Equilibrium

We now establish the existence of the equilibrium described above, assuming that the two additional parameter restrictions hold. We proceed in two steps. First, we derive an expression for aggregate imports. Second, we establish that the real output is uniquely pinned down.

[12] Capital-rich southern entrepreneurs supply the profit-maximizing quantity $\widetilde{y}$ in the southern market (where they enjoy monopoly power). Capital that is not used in the production of the domestically sold units is either used to produce for the (competitive) northern market or is supplied in the domestic credit market. As noted above, at $\rho = a/\tau$, the capital-rich southern entrepreneurs are exactly indifferent between these two alternatives.

Aggregate exports. Total consumption expenditures on an arbitrary good supplied by an entrepreneur with $\omega < \omega_\tau^I$ are $\tau c(\tau) = YP^{\sigma-1}\tau^{1-\sigma}$. To get the value of imports, we have to deduct the value of the domestic production. Moreover, with balanced trade, the total value of all imports must be equal to the value of all exports, EXP. As a result, we have

$$\begin{aligned} EXP &= YP^{\sigma-1}\tau^{1-\sigma}G(\omega_\tau^I) \\ &\quad -\tau\int_0^{\omega_\kappa^I}\frac{b}{1-\lambda\tau^2 b/a}\omega dG(\omega) - \tau\int_{\omega_\kappa^I}^{\omega_\tau^I}\frac{a}{1-\lambda\tau^2}\omega dG(\omega), \end{aligned}$$

where the first term on the right-hand side gives total expenditures on all goods that are imported (i.e., goods produced by firms with $\omega < \omega_\tau^I$); the second term is the total value of goods produced by domestic firms with $\omega < \omega_\kappa^I$ (i.e., by low-productivity firms); and the third term gives the total value of goods produced by domestic firms with $\omega_\kappa^I \leq \omega < \omega_\tau^I$ (i.e., by high-productivity firms with an output that is too small to meet demand at price τ).

Resource constraint. To find an expression for (gross-)capital demand, note first that from (12) and $\rho = a/\tau$ we have $\widetilde{y} = (Y/P)P^\sigma\tau^\sigma\left((\sigma-1)/\sigma\right)^\sigma$ and $\widetilde{\omega} = (1-\lambda(\sigma/(\sigma-1))\left(\widetilde{y}/a\right)$. With these expressions in mind, the credit market equilibrium condition reads

$$\begin{aligned} K &= \int_0^{\omega_\kappa^I}\frac{1}{1-\lambda\tau^2 b/a}\omega dG(\omega) + \int_{\omega_\kappa^I}^{\omega_\tau^I}\frac{1}{1-\lambda\tau^2}\omega dG(\omega) + \int_{\omega_\tau^I}^{\widetilde{\omega}}\frac{\overline{y}^I(\omega)}{a}dG(\omega) \\ &\quad + \int_{\widetilde{\omega}}^{\infty}\frac{\widetilde{y}}{a}dG(\omega) + \tau\frac{EXP}{a}, \end{aligned}$$

where $\overline{y}^I(\omega)$ is implicitly determined by (9'). Using the expression for total exports, EXP, derived above, the equilibrium condition can be rewritten as

$$\begin{aligned} K &= \int_0^{\omega_\kappa^I}\frac{1-\tau^2 b/a}{1-\lambda\tau^2 b/a}\omega dG(\omega) + \int_{\omega_\kappa^I}^{\omega_\tau^I}\frac{1-\tau^2}{1-\lambda\tau^2}\omega dG(\omega) + \int_{\omega_\tau^I}^{\widetilde{\omega}}\frac{\overline{y}^I(\omega)}{a}dG(\omega) \\ &\quad + \frac{1}{a}YP^{\sigma-1}\tau^\sigma\left(\frac{\sigma-1}{\sigma}\right)^\sigma[1-G(\widetilde{\omega})] + \frac{1}{a}YP^{\sigma-1}\tau^{2-\sigma}G(\omega_\tau^I). \end{aligned}$$

The following proposition shows that this condition pins down a unique equilibrium.

Proposition 2 *Suppose that conditions (R2) and (R3) hold and that κ is sufficiently low (in a sense made clear in the proof). Then, there exists a unique macroeconomic equilibrium (i.e., an equilibrium with the values of Y/P and ρ/P uniquely pinned down) where (i) the poorest entrepreneurs use the low-productivity technology; (ii) all poorer entrepreneurs are price-constrained* *and face import competition; (iii) all richer entrepreneurs set the profit-maximizing price; (iv) the richest entrepreneurs export parts of their output.*

Proof. See Appendix. ■

The properties of this equilibrium are – in addition to the evidence discussed after Proposition 1 – consistent with stylized facts about the relative performance of exporting firms (see, e.g., Bernard et al., 2003). In particular, the firms that export parts of their production tend to be the biggest ones and they are also more productive than the average firm in the economy (since some import-competing small firms use the low-productivity technology). Moreover, to the extent that the set of richest entrepreneurs is relatively small, exporting firms are a minority. The mechanism behind these implications is, however, entirely different from the one in the standard models of trade and heterogeneous firms (i.e., Bernard et al., 2003; Melitz, 2003). Here, in an environment characterized by credit market frictions and inequality, it is the wealth endowment that determines whether an entrepreneur can access the resources required to operate the high-productivity technology and to enter export markets.

4.2.3 The Impact of Lower Trade Costs on Real Output

A fall in trade costs affects aggregate real output through three different channels, two negative and one positive. We now introduce and discuss these channels. Section 4.3 below will then focus on their relative strength and establish two analytical results (Propositions 3 and 4); Section 4.3 will also present findings from a quantitative exercise.

Here we start by stating how much capital price-constrained firms (i.e., import-competing entrepreneurs with $\omega_\tau^I < \omega$) invest in the intermediate-trade-costs equilibrium described by Proposition 2. Taking into account that $\rho = a/\tau$, equation (9') immediately implies

$$k(\omega)|_{\omega<\omega_\tau^I} = \frac{1}{1-\lambda\tau^2 q/a}\omega, \;\; q \in \{a, b\}, \tag{18}$$

where $q = b$ if $\omega < \omega_\kappa^I$ (low-productivity firms) and $q = a$ otherwise (high-productivity firms).

With this in mind, we now turn to the first adverse channel by which a fall in trade costs affects Y/P. This channel is associated with the impact of trade costs on the minimum wealth level required to operate the high-productivity technology, ω_κ^I. Because $\omega_\kappa^I = \left(1-\lambda\tau^2\right)\kappa$ is negatively related to τ, a fall in trade costs increases the number of firms using the low-productivity technology, $G(\omega_\kappa^I)$. This result is a consequence of the credit-market imperfection. As τ shrinks, the maximum price that can be demanded by the price-constrained firms decreases while the cost of borrowing ($\rho = a/\tau$) increases. As a result, mark-ups – and hence profit margins – shrink, implying that these firms face a reduction in the collateral they can put up. Less collateral, in turn, implies a lower borrowing capacity so that some additional firms become unable to meet the κ-threshold. In what follows, we call this effect *polarization effect* as it reinforces the (preexisting) polar structure of the economy, i.e., the coexistence of small low-productivity firms and efficient large-scale companies.

While the polarization effect leads to a fall in unweighted average firm productivity, it does not necessarily imply a reduction in capital-weighted average productivity: Because preexisting low-productivity firms experience a decline in their ability to borrow as well, they are forced to invest less. The share of capital invested in low-productivity firms is given by

$$\beta = \int_0^{\omega_\kappa^I} k(\omega)|_{\omega<\omega_\tau^I} \, dG(\omega)/K = \frac{1}{1-\lambda\tau^2 b/a} \int_0^{(1-\lambda\tau^2)\kappa} \omega dG(\omega)/K,$$

where the second equal sign makes us of equation (18) and of $\omega_\kappa^I = \left(1-\lambda\tau^2\right)\kappa$. Clearly, the sign of the impact of lower trade costs on the above expression – and hence on capital-weighted average productivity – depends on the parameters of the model and on the mass of entrepreneurs at ω_κ^I. If the latter is sufficiently large, a gradual reduction in trade costs implies that a larger fraction of the capital stock is used in low-productivity firms. Put differently, in this case, the pro-competitive effects of trade impair, rather than improve, capital-weighted average firm productivity. The quantitative exercise in the following subsection shows that such a negative impact of a falling τ on capital-weighted average firm productivity can be observed over a broad range of trade costs. To summarize:

Lemma 5 (Polarization effect) *In the equilibrium described in Proposition 2, a fall in trade costs τ (i) increases the number of firms $G(\left(1-\lambda\tau^2\right)\kappa)$ using the low-productivity technology; (ii) may reduce capital-weighted average firm productivity.*

Proof. In text. ■

The second adverse channel, which we call *replacement effect*, is again related to the credit-market imperfection. As discussed above, a fall in τ forces the price-constrained firms – high- and low-productivity alike – to invest less, which can be seen from equation (18). As a result, the domestic output of goods produced by price-constrained firms falls, whereas the domestic demand for goods produced by those firms rises because of the lower limit price τ. The loss of output produced by price-constrained firms must be replaced with additional imports from abroad (which also cover any increase in demand);[13] at the same time, absorbing capital no

[13] This replacement effect is reminiscent of a mechanism discussed in a paper by Brander and Krugman (1983). They show that the rivalry of oligopolistic firms can lead to "reciprocal dumping" (i.e., two-way trade in the same product) and hence to "wasteful" spending on transportation.

longer employed by the price-constrained firms, large companies increase their output and send more goods abroad, thereby keeping trade balanced. These adjustments are a source of inefficiency as they may force the economy to spend more, rather than less, resources on transportation costs in response to a fall in τ. To summarize:

Lemma 6 (Replacement effect) *In the equilibrium described in Proposition 2, a fall in trade costs τ reduces the output by price-constrained firms. The resulting additional shortfall of domestic production relative to demand will be met by imports.*

Proof. In text. ■

On the other hand, a fall in τ has a positive effect on Y/P by reducing the dispersion of prices in the domestic economy. The lower end of the price range is marked by $p(\widetilde{y})$, the price charged by firms that are not credit constrained. According to equation (17), $p(\widetilde{y}) = (1/\tau)(\sigma/(\sigma-1))$. The highest price is the limit price τ, charged by the price-constrained firms. So a fall in τ reduces the ratio of the highest price to the lowest price, $\tau^2(\sigma-1)/\sigma$, thereby inducing individuals to consume a more balanced goods basket (equation 4).[14] As a result, the variation in the marginal utility of consumption across goods falls; thus, other things equal, the welfare of the average individual (i.e., the aggregate real output, Y/P) rises. To summarize:

Lemma 7 (Reduction in price dispersion) *In the equilibrium described in Proposition 2, a fall in trade costs τ reduces the ratio of the highest to the lowest price paid in the economy, thereby narrowing down the variation in the marginal utility of consumption across goods.*

Proof. In text. ■

Finally, it is worthwhile to point out that a fall in trade costs does not only affect the level of the aggregate income but also the income distribution, which becomes more polarized. To see this, note that the nominal rate of return in unconstrained firms is a/τ, whereas the rate of return in price-constrained firms is given by $(1-\lambda)\tau b/(1-\lambda\tau^2(b/a))$ if the the low-productivity technology is used; and by $(1-\lambda)\tau a/(1-\lambda\tau^2)$ otherwise. Thus, lowering trade costs increases incomes in the higher parts of the distribution and diminishes those at the bottom. As a result, higher incomes gain disproportionally (which confirms a similar finding in the more parsimonious setting presented in Foellmi and Oechslin, 2010).

4.3 From Autarky to Full Integration

We now broaden our focus and explore how the economy is affected by the three channels when trade costs fall from prohibitive levels to zero. Relying on the general version of the model,

[14] Note that (R2), the central condition under which Proposition 2 is derived, implies $\tau^2(\sigma-1)/\sigma > 1$.

we start by focusing on the impact on the aggregate real output at the point that separates the autarky equilibrium from the neighboring "trade equilibrium" ($\tau = \tau^{AT}$); and at the point where trade costs fall to zero ($\tau = 1$). For the rest of the analysis, we then assume that capital endowments are distributed according to a Pareto distribution.

4.3.1 Autarky and Full Integration

$\tau = \tau^{AT}$. Whether or not the two regions exchange goods in equilibrium is determined by the trade costs, other things equal. If τ is so high that even firms with a zero wealth endowment ($\omega = 0$) are able to set their constrained-optimal price, there is no trade between North and South. However, as soon as τ turns into a binding maximum price, trade emerges.

The critical threshold in this regard can be calculated explicitly. Consider an autarky equilibrium in which the poorest entrepreneurs (i.e., those with $\omega = 0$) are forced to use the low-productivity technology.[15] The highest price charged in such an equilibrium is $p(\bar{y}(0))$, where $p(\cdot)$ is given by (5) and $\bar{y}(0)$ can be calculated using (10). Observing these functional forms, we obtain $p(\bar{y}(0)) = \rho/(b\lambda)$. We further know that the borrowing rate in a trade equilibrium equals a/τ. Thus, at the border between autarky and the neighboring trade equilibrium, we must have $p(\bar{y}(0)) = a/(b\lambda\tau)$. As a result, the critical τ-threshold is given by

$$\tau^{AT} \equiv (a/(b\lambda))^{1/2}.$$

The following proposition establishes how trade costs affect real output at this threshold.

Proposition 3 *Suppose that $\tau = \tau^{AT}$, and consider an equilibrium where entrepreneurs with a zero wealth endowment ($\omega = 0$) use the low-productivity technology. Then, a (marginal) reduction in trade costs, τ, leads to a fall in aggregate real output:*

$$\left.\frac{d(Y/P)}{d\tau}\right|_{\tau=\tau^{AT}} > 0.$$

Proof. See Appendix. ■

Note that the output declines as τ falls below τ^{AT} although some smaller firms rely on the low-productivity technology (implying that the supply of goods is particularly uneven). This result continues to hold in the alternative case where all firms have access to the high-productivity technology under autarky (as can be shown using an approach similar to the one in

[15] This is the case if $\omega_\kappa > 0$. From equation (8) we can conclude that $\omega_\kappa > 0$ is equivalent to $\kappa > (\lambda x)^\sigma a^{\sigma-1}$, where x is an endogenous variable defined in equation (9). From the proof of Proposition 1 we can conclude that x takes a finite value in equilibrium. So, other things equal, $\omega_\kappa > 0$ must hold if λ is sufficiently small. For completeness, we note that it is easy to check that the above condition and condition (11) are compatible as long as the credit market imperfection is relevant, i.e., as long as $\lambda < \sigma/(\sigma - 1)$.

the proof of Proposition 3).[16] The negative impact of trade in the neighborhood of τ^{AT} is due to the fact the reduction in mark-ups forces the smallest firms to downsize substantially. Put differently, the negative replacement effect has first-order consequences, while the reduction in price dispersion is only a second-order effect.

$\tau = 1$. At the other end of the interesting spectrum of trade costs, the southern goods market is fully integrated into the northern one. Prices and marginal costs are equal to one, and we have $\rho = a$. Given this, only the high-productivity technology is used, while firm profits are equal to zero (implying indifference between running a firm and lending). According to (16), the capital endowment that just allows an entrepreneur to operate the high-productivity technology, ω_κ^I, is given by $\kappa(1-\lambda) > 0$. So any agent with $\omega \geq \omega_\kappa^I$ may run a firm, and – given that the agent decides to do so – the size of her investment falls in the range $[\kappa, \omega(1-\lambda)^{-1}]$, where the upper bound is a consequence of the credit market friction. Goods for which domestic supply falls short of demand (or goods that cannot be produced in the South at all) are imported from the North. Yet, since trade costs are zero, this does not lead to any inefficiency. Aggregate real output is thus at its maximum level: $Y/P = aK$.

Starting from this first-best situation, a marginal rise in trade costs must have a negative impact on the aggregate real output. Since a positive mass of goods must be imported, a rise in τ (from 1) means that the fraction of resources spent on trade costs, rather than on producing output, increases from zero to a positive level. Consequently, the first-best output can no longer be attained. We can therefore state the following result:

Proposition 4 *Suppose that $\tau = 1$, so that the aggregate real output takes its first-best level, aK. Then, a (marginal) increase in trade costs, τ, leads to a fall in aggregate real output:*

$$\left.\frac{d(Y/P)}{d\tau}\right|_{\tau=1} < 0.$$

Proof. In text. ■

4.3.2 Partial Integration: A Quantitative Exercise

If τ is in-between the two polar values τ^{AT} and 1, the consequences of falling trade costs depend on the distribution of capital endowments, $G(\omega)$, and on the choice of parameter values (see the discussion in Subsection 4.2.3). As for capital endowments, we assume from now on that they

[16] Note further that Proposition 3 does not depend on the assumption that the lowest wealth level is zero (rather than positive) nor on the fact that we impose a continuous wealth distribution (rather than a discrete one). Detailed derivations are available from the authors on request.

are distributed according to a Pareto distribution. In the literature on inequality, there is a long tradition of using the Pareto law to describe wealth or income distributions, in particular when it comes to the right tail (see, e.g., Atkinson et al., 2011). Our choice of parameter values is based on data from India, a country that went through a sweeping trade liberalization episode in the 1990s (see, e.g., Topalova and Khandelwal, 2011).

To come up with a value for the inverted Pareto coefficient, which is set equal to 1.81, we rely on Davies et al. (2011) who provide relatively detailed wealth-distribution data for a number of countries, among them India.[17] Following Moll (2014), the parameter λ is chosen so that the maximum leverage ratio in absence of market power, $1/(1-\lambda)$, is 1.2 (Moll, in turn, relies on data from Beck et al., 2000, to obtain an estimate for the Indian maximum leverage ratio). This gives us $\lambda = 0.17$. Our choice for the elasticity of substitution, σ, and the ratio of "physical productivities", a/b, is guided by Hsieh and Klenow (2009) who study the extent of factor misallocation in several countries, among them India. In particular, following Hsieh and Klenow, we set $\sigma = 3$. To discipline our choice of a/b, we rely on Hsieh and Klenow's Table I which provides information on the distribution of physical productivities (TFPQ). This information allows us to come up with estimates of productivity ratios, for instance the ratio of the productivity of the firm at the 55th percentile to that of the firm at the 45th percentile.[18] As the productivity ratio is an important determinant of the size of the efficiency loss caused by credit market frictions, we take a conservative approach. Specifically, we provide simulations for the three ratios 1.33, 1.50, and 1.77. These ratios are conservative in the sense that they reflect productivity differentials between firms which are close to the median of the distribution: 1.33 and 1.77 correspond, respectively, to the 55th-to-45th and 60th-to-40th percentile ratio (while 1.50 corresponds to the percentile ratio that is exactly in-between). Finally, we impose $K = 1$ and set $\kappa = 0.85$. Together with the normalization $a = 1$, assuming $K = 1$ implies that the first-best level of the aggregate real output is also equal to unity.

Table 2 here

Columns (1), (3), and (5) of Table 2 show how the aggregate real output adjusts in response to a gradual fall in trade costs from a prohibitive level ($\tau^{AT} \simeq 1.45$) to zero ($\tau = 1$). Under all

[17] For any arbitrary wealth level ω^*, the inverted Pareto coefficient is the ratio of average wealth of individuals with $\omega \geq \omega^*$ to ω^*. Using standard methods, we determine the inverted Pareto coefficient by using the top-5% and the top-1% wealth share (38.3% and 15.7%, respectively) listed in Table 5 of Davies et al. (2011).

[18] Hsieh and Klenow (2009) report the 75th-to-25th percentile ratio for various years. We use the number for 1987 (which is 4.71) to parameterize a Pareto distribution, which is then used to calculate different percentile ratios. Assuming that productivities follow a Pareto distribution is a usual approach in the literature.

three parameterizations considered, as τ decreases, Y/P falls first monotonically to a global minimum before it starts to approach its first-best level. The maximum loss in terms of aggregate real output ranges from about 13% if $a/b = 1.33$ to about 17% if $a/b = 1.77$. We consider these to be significant effects, not least because we rely on conservative a/b ratios. It is further worthwhile to note that for Y/P to return to its autarky level τ must fall below 1.1. This means that the two negative pro-competitive effects, the polarization effect and the replacement effect, dominate the gains associated with a falling price dispersion (beneficial pro-competitive effect) over a broad range. This findings does not appear to be particularly sensitive to assuming that the distribution of capital is Pareto. An earlier version of this paper, Foellmi and Oechslin (2013), presents simulations based on a two-point distribution and documents similar results in qualitative and quantitative terms.

Columns (2), (4), and (6) of Table 2 indicate the share of capital invested in low-productivity firms, β. As discussed in Subsection 4.2.3, the impact of falling trade costs on β is ambiguous: The polarization effect increases the number of firms using the less productive technology, while the tightening of borrowing constraints reduce investment by the existing low-productivity firms. However, for all parameterizations considered, the picture is very similar: As τ falls, β increases until τ reaches the point where the low-productivity entrepreneurs choose to become lenders – and hence go out of business. Table 2 indicates that this point is reached later if the productivity ratio a/b is lower. In sum, relying on parameter values informed by Indian data, our quantitative exercise demonstrates that a gradual increase in competitive pressure may reduce, rather than improve, capital-weighted average firm productivity.

Finally, our simulation results can be linked to adjustments observed in India in the early 1990s. In 1991, the average output tariff in India was still extremely high. However, between 1991 and 1994, it fell by about one third (according to Topalova and Khandelwal, 2011, Table 1). Exactly for this period, Hsieh and Klenow (2009) report two surprising facts. *First*, the ratio of the actual aggregate output to the "efficient" output fell from about 49% in 1991 to 44% in 1994, implying a decline in allocative efficiency.[19] *Second*, between 1991 and 1994, there was an increase in the standard deviation of physical productivities (TFPQ) across firms. Interpreting a fall in τ as a decline in tariffs, our simulations generate similar outcomes in qualitative terms. Starting from an initial tariff rate close to, but below, the autarky level, a substantial decline in

[19] These two numbers can be calculated from the information provided in Hsieh and Klenow's (2009) Table IV. In their multiple-sector and multiple-distortions model, the efficient output is attained if – due to the absence of any distortions – the revenue productivity (TFPR) is equalized across firms within each sector. In our one-sector model, the efficient output (i.e., the output generated in absence of any credit market distortions) is equal to one under the current choice of parameters.

tariffs – e.g., one of about one third, from $\tau = 1.40$ to $\tau = 1.25$ – reduces the actual aggregate output according to all three parameterizations. As a result, in all three cases, the ratio of the actual aggregate output to the efficient output falls. Moreover, for the case $a/b = 1.33$, we observe that such a tariff cut increases the share of capital invested in low-productivity firms from a low level to about 20%. As a result, the capital-weighted standard deviation of physical productivities increases. So, while the surprising empirical pattern documented for India by Hsieh and Klenow (2009) is hard to replicate in standard heterogeneous-firms models, our simulations suggest that it may arise naturally in the present setup.

4.4 Discussion

When deriving the implications of trade between the North and the South, an important assumption so far has been that the two regions produce the same spectrum of goods. We now briefly discuss how robust the model's implications are to different assumptions regarding the northern goods spectrum. We consider two alternative modifications in turn.

The first alternative assumption is that the range of goods produced in the South forms a subset of a broader set of goods produced in the North. In this case, since the utility function exhibits love for variety, the positive channel by which a fall in trade costs affects aggregate real output (reduction in price dispersion) is quantitatively stronger. In qualitative terms, however, a fall in trade costs has similar effects as in the baseline model. In particular, as τ shrinks, the maximum price that can be demanded by the price-constrained entrepreneurs decreases while the cost of borrowing ($\rho = a/\tau$) increases. Both effects tighten the financial constraints of smaller firms and hence raise the minimum wealth level required to operate the high-productivity technology. As a result, as is the case in the baseline model, the share of firms using the low-productivity technology will increase when trade costs fall.

Quite a distinct situation arises when North and South produce different goods (so that the northern spectrum complements the southern one) and northern firms, just as their southern counterparts, have some degree of monopoly power. In this polar case, a reduction in trade costs does not affect demand elasticities – and hence does not lead to more competitive pressure in the South. Moreover, all firms have the opportunity to export parts of their production. Consequently, for financially constrained southern firms, the pledgeable income will be larger than in the baseline setup (where southern demand becomes perfectly elastic if a price reaches τ). On the other hand, as is the case in the baseline setup, a fall in trade costs raises the value marginal product of capital and hence the cost of borrowing. The former effect (rise in pledgeable income) loosens borrowing constraints, while the latter one (higher borrowing costs) tightens them. One can show that the net effect on the borrowing capacity of credit-constrained firms is exactly zero.[20] As a result, if southern firms retain their monopoly power, the share of firms using the low-productivity technology remains unchanged when τ falls, as does the share of capital invested by low-productivity firms.

Note, however, that these results are only obtained in the polar case in which demand elasticities are completely unaffected by a fall in trade costs. In an intermediate case, in which a fall in τ increased demand elasticities gradually (e.g., because northern goods are imperfect substitutes for southern ones), the pledgeable income would rise less sharply. As a result, the net effect of a fall in τ on the borrowing capacity of credit-constrained firms would no longer be zero but negative as in the baseline model. So, yet again, we would get that a fall in trade costs raises the share of firms using the low-productivity technology, thereby possibly reducing average firm productivity and the aggregate real output.

5 Conclusion

We study the macroeconomic implications of trade liberalization in an economy that features three basic elements: Credit market frictions, technology choice, and some degree of monopoly power in the goods markets. In contrast to much of the recent literature, which primarily emphasizes beneficial pro-competitive effects of trade, we find that a partial integration into world markets may actually worsen the allocation of production factors and reduce overall output. The reason is that a partial integration lowers mark-ups and hence the borrowing capacity of the less affluent entrepreneurs. So, for small or medium-sized firms, lower trade barriers mean less access to external financing, a prediction we substantiate using a recent firm-level dataset covering seven Latin American countries.

In our model, a deterioration in the access to credit affects economic performance through two different channels. First, while not driven out of the market, some smaller firms are forced to switch to a less productive technology (polarization effect). Second, the loss in output generated by the smaller firms must be compensated through higher imports – which requires the economy to spend more on trade-related costs (replacement effect). It is further clear that these changes in the use of technologies and firm sizes are reflected in the income distribution: While the owners of smaller firms lose, the most affluent entrepreneurs win substantially – which implies a further polarization of the distribution of incomes.

The result that in the present setup the overall output may – and in some cases must –

[20] Detailed derivations are available from the authors upon request.

fall in response to a gradual decline in trade costs is an illustration of the theorem of the second best. From this literature we know that lower trade barriers may lead to losses if the result is an even sharper deviation of the actual output distribution from the undistorted one (Bhagwati, 1971). We show that credit market frictions may be responsible for such harmful adjustments. Lower trade barriers tighten the borrowing constraints faced by smaller firms and force them to invest less, thereby increasing the extent of under-production. On the other hand, absorbing capital no longer employed by the constrained small firms, large companies increase their output – which means even more over-production by these firms.

While we show that the pro-competitive effects of international trade may be harmful in economies characterized by significant financial frictions, our analysis does not suggest that such economies should stay away from trade liberalization. Such a conclusion would be inappropriate for at least three reasons. First, our model does not allow trade to provide benefits through channels other than a more balanced provision of goods. Second, we find that an opening of trade may be harmful only if it is incomplete. A reform that brings trade costs close to zero will always be beneficial. Third, even a modest reduction in trade barriers could be helpful if it were implemented together with complementary reforms.[21] Since the negative pro-competitive effects of a partial trade liberalization come from tighter credit constraints, the complementary measures should concentrate on the credit market. One option would be to improve credit contract enforcement. If the improvement were sufficiently strong, the borrowing constraints faced by small firms would ease even though mark-ups shrink.

A significant improvement in the quality of credit contract enforcement may be difficult to achieve, though. It would require substantial institutional reform (such as the introduction of India-style Debt Recovery Tribunals) and hence be very time-consuming or infeasible. There is, however, a less ambitious alternative. Since a firm's borrowing capacity is negatively related to the borrowing rate, introducing a subsidized-credit scheme for constrained firms would have a very similar effect. The subsidy could be financed through an income tax which has upon introduction welfare costs of second order only (in the present framework it would not lead to any further distortions at all). It is finally worthwhile to note that our analysis, relying on a general equilibrium framework with technology choice, suggests that smaller firms should be the target of subsidized-credit schemes. The related trade and finance literature, which primarily emphasizes fixed costs of entering foreign markets, would rather suggest that such programs should be directed towards big export-oriented companies.

[21] A sizeable reduction might be infeasible because the remoteness of the place implies high trade costs even if tariffs are negligible; or the lack of a tax bureaucracy means that the state is forced to rely on trade taxes.

References

[1] Acemoglu, Daron and Fabrizio Zilibotti (2001); "Productivity Differences," *Quarterly Journal of Economics*, 116(2), 563-606.

[2] Antràs, Pol and Ricardo Caballero (2009); "Trade and Capital Flows: A Financial Frictions Perspective," *Journal of Political Economy*, 116(2), 701-744.

[3] Amiti, Mary and David Weinstein (2011); "Exports and Financial Shocks", *Quarterly Journal of Economics*, 126(4), 1841-1877.

[4] Atkinson, Anthony, Thomas Piketty, and Emmanuel Saez (2011); "Top Incomes in the Long Run of History", *Journal of Economic Literature*, 49(1), 3-71.

[5] Banerjee, Abhijit and Esther Duflo (2005); "Growth Theory Through the Lens of Development Economics," in: Aghion, P. and S. Durlauf, eds., *Handbook of Economic Growth*, Vol. 1A. Amsterdam: Elsevier.

[6] Banerjee, Abhijit and Esther Duflo (2010); "Giving Credit Where It is Due", *Journal of Economic Perspectives*, 24(3), 61-80.

[7] Banerjee, Abhijit and Benjamin Moll (2010); "Why Does Misallocation Persist?", *American Economic Journal: Macroeconomics*, 2(1), 189-206.

[8] Banerjee, Abhijit and Andrew Newman (1993); "Occupational Choice and the Process of Development," *Journal of Political Economy*, 101(2), 274-298.

[9] Banerjee, Abhijit and Andrew Newman (2004); "Notes for Credit, Growth, and Trade Policy", unpublished manuscript, MIT.

[10] Banerjee, Abhijit and Thomas Piketty (2005); "Top Indian Incomes, 1922-2000," *World Bank Economic Review* 19(1), 1-20.

[11] Beck, Thorsten, Asli Demirguc-Kunt, and Ross Levine (2000); "A New Database on the Structure and Development of the Financial Sector", *World Bank Economic Review*, 14(3), 597-605.

[12] Bernard, Andrew, Jonathan Eaton, J. Bradford Jensen, and Samuel Kortum (2003); "Plants and Productivity in International Trade", *American Economic Review*, 93(4), 1268-1290.

[13] Besedeš, Tibor, Byung-Cheol Kim, and Volodymyr Lugovskyy (2014); "Export Growth and Credit Constraints", *European Economic Review*, 70, 350-370.

[14] Bhagwati, Jagdish (1971); "The Generalized Theory of Distortions and Welfare", in Bhagwati, J. et al., eds., *Trade, Balance of Payments and Growth*. Amsterdam and London: North-Holland.

[15] Brander, James and Paul Krugman (1983); "A 'Reciprocal Dumping' Model of International Trade", *Journal of International Economics*, 15(3-4), 313-321.

[16] Bustos, Paula (2011); "Trade Liberalization, Exports, and Technology Upgrading: Evidence on the Impact of MERCOSUR on Argentinian Firms", *American Economic Review*, 101(1), 304-340.

[17] Davies, James, Susanna Sandström, Anthony Shorrocks, and Edward Wolff (2011); "The Level and Distribution of Global Household Wealth", *Economic Journal*, 121(March), 223-254.

[18] DeJong, David and Marla Ripoll (2006); "Tariffs and Growth: An Empirical Exploration of Contingent Relationships", *Review of Economics and Statistics*, 88(4), 625-640.

[19] Djankov, Simeon, Rafael La Porta, Florencio López-de-Silanes, and Andrei Shleifer (2002); "The Regulation Of Entry", *Quarterly Journal of Economics*, 117(1), 1-37.

[20] Dowrick, Steve and Jane Golley (2004); "Trade Openness and Growth: Who Benefits?", *Oxford Review of Economic Policy*, 20(1), 38-56.

[21] Egger, Hartmut and Udo Kreickemeier (2009); "Firm Heterogeneity and the Labor Market Effects of Trade Liberalization", *International Economic Review*, 50(1), 187-216.

[22] Epifani, Paolo and Gino Gancia (2011); "Trade, Markup Heterogeneity and Misallocations", *Journal of International Economics*, 83(1), 1-13.

[23] Feenstra, Robert, Zhiyuan Li, and Miaojie Yu (2011); "Exports and Credit Constraints under Incomplete Information: Theory and Evidence from China", NBER Working Paper 16940.

[24] Felbermayr, Gabriel, Julien Prat, and Hans-Jörg Schmerer (2011); "Trade and Unemployment: What Do the Data Say?", *European Economic Review*, 55(6), 741-758.

[25] Foellmi, Reto and Manuel Oechslin (2010); "Market Imperfections, Wealth Inequality, and the Distribution of Trade Gains", *Journal of International Economics*, 81(1), 15-25.

[26] Foellmi, Reto and Manuel Oechslin (2013); "Globalization and Productivity in the Developing World", unpublished manuscript, Tilburg University.

[27] Foellmi, Reto, Stefan Legge, and Alexa Tiemann (2015); "Innovation and Trade in the Presence of Credit Constraints", CEPR Discussion Paper No. 10391.

[28] Galor, Oded and Joseph Zeira (1993); "Income Distribution and Macroeconomics," *Review of Economic Studies*, 60(1), 35-52.

[29] Helpman, Elhanan, Oleg Itskhoki, and Stephen Redding (2010); "Inequality and Unemployment in a Global Economy", *Econometrica*, 78(4), 1239-1283.

[30] Hsieh, Chang-Tai and Peter Klenow (2009); "Misallocation and Manufacturing TFP in China and India", *Quarterly Journal of Economics*, 124(4), 1403-1448.

[31] Kambourov, Gueorgui (2009); "Labour Market Regulations and the Sectoral Reallocation of Workers: The Case of Trade Reforms", *Review of Economic Studies*, 76(4), 1321-1358.

[32] Kehoe, Timothy and Kim Ruhl (2010); "Why Have Economic Reforms in Mexico Not Generated Growth?", *Journal of Economic Literature*, 48(4), 1005-10273.

[33] Lileeva, Alla, and Daniel Trefler (2010); "Improved Access to Foreign Markets Raises Plantlevel Productivity . . . For Some Plants", *Quarterly Journal of Economics*, 125(3), 1051-1099.

[34] Manova, Kalina (2013); "Credit Constraints, Heterogeneous Firms, and International Trade", *Review of Economic Studies*, 80(2), 711-744.

[35] Matsuyama, Kiminori (2000); "Endogenous Inequality," *Review of Economic Studies,* 67(4), 743-59.

[36] Matsuyama, Kiminori (2005); "Credit Market Imperfections and Patterns of International Trade and Capital Flows", *Journal of the European Economic Association*, 3(2-3), 714-723.

[37] McMillan, Margaret and Dani Rodrik (2011); "Globalization, Structural Change, and Productivity Growth", NBER Working Paper 17143.

[38] Melitz, Marc (2003); "The Impact of Trade on Intra-Industry Reallocations and Aggregate Industry Productivity", *Econometrica*, 71(6), 1695–1725.

[39] Melitz, Marc and Giancarlo Ottaviano (2008); "Market Size, Trade, and Productivity", *Review of Economic Studies*, 75(1), 295-316.

[40] Moll, Benjamin (2014); "Productivity Losses from Financial Frictions: Can Self-Financing Undo Capital Misallocation?", *American Economic Review*, forthcoming.

[41] Nataraj, Shanthi (2011); "The impact of Trade Liberalization on Productivity: Evidence from India's Formal and Informal Manufacturing Sectors", *Journal of International Economics*, 85(2), 292-301.

[42] Pavcnik, Nina (2002); "Trade Liberalization, Exit, and Productivity Improvements: Evidence from Chilean Plants", *Review of Economic Studies*, 69(1), 245-276.

[43] Peters, Katrin and Monika Schnitzer (2012); "Trade Liberalization and Credit Constraints: Why Opening Up May Fail to Promote Convergence", CEPR Discussion Paper No. DP8942.

[44] Song, Zheng, Kjetil Storesletten, and Fabrizio Zilibotti (2011); "Growing Like China", *American Economic Review*, 101(1), 202-241.

[45] Topalova, Petia and Amit Khandelwal (2011); "Trade Liberalization and Firm Productivity: The Case of India", *Review of Economics and Statistics*, 93(3), 995-1009.

[46] Warner, Andrew (2003); "Once More Into the Breach: Economic Growth and Global Integration", Center for Global Development Working Paper Number 34.

[47] Yanikkaya, Halit (2003); "Trade Openness and Economic Growth: A Cross-Country Empirical Investigation", *Journal of Development Economics*, 72(1), 57-89.

APPENDIX: PROOFS

Proof of Proposition 1. (i) We focus first on the case $\lambda < (\sigma-1)/\sigma$ (credit rationing). In order to establish that there is a unique macroeconomic equilibrium, we proceed in two steps. We first show the existence of a unique equilibrium value of x. In a second step, we prove then that Y/P and ρ/P are uniquely pinned down.

To achieve the first step, observe that the equilibrium value of x must solve $K^D(x) = K$, where $K^D(x)$ is given by (14). Suppose now that x is exactly equal to the threshold given in (11). Then, $\widetilde{y}(x)/a$ is equal to κ whereas both $\overline{y}(\omega; x)/a$ (with $\omega \in [\omega_\kappa, \widetilde{\omega})$) and $\overline{y}(\omega; x)/b$ (with $\omega < \omega_\kappa$) are strictly smaller than κ. As a result, K^D must also be strictly smaller than κ. Moreover, since $\kappa < K$ due to (R1), we have $K^D < K$. Assume now that $x \to \infty$. Obviously, under these circumstances, we have $K^D \to \infty > K$. Finally, to show that there is a unique value that solves the equilibrium condition $K^D(x) = K$, we now establish that K^D increases monotonically as x rises from the threshold in (11) to infinity. Expressions (10) and (12) imply that both $\overline{y}(\omega; x)$ and $\widetilde{y}(x)$ are monotonically increasing in x. Moreover, the threshold ω_κ falls in x which reinforces the increase in capital demand since

$$\left[\frac{\overline{y}(\omega_\kappa^-)}{b} - \frac{\overline{y}(\omega_\kappa^+)}{a}\right] g(\omega_\kappa)\frac{d\omega_\kappa}{dx} \geq 0.$$

Thus, we have $K^D(x)/dx > 0$, and the proof of the first step is complete.

To show also that ρ/P (and hence Y/P) is uniquely pinned down, we make use of the CES price index. The first step is to find an expression for the price associated with an output level $\widetilde{y}$. To do so, we apply the expressions for x and $\widetilde{y}$ in (5) and get $p(\widetilde{y}) = (\rho/a)(\sigma/(\sigma-1))$. With this expression in mind, the definition of the CES price index implies

$$P^{1-\sigma} = \int_0^{\widetilde{\omega}} [p(\overline{y}(\omega))]^{1-\sigma}\, dG(\omega) + \left[\frac{\sigma}{\sigma-1}\frac{\rho}{a}\right]^{1-\sigma} [1 - G(\widetilde{\omega})]. \tag{19}$$

Then, relying again on (5) to substitute for $p(\overline{y}(\omega))$, we eventually obtain

$$\left(\frac{\rho}{P}\right)^{\sigma-1} = \int_0^{\widetilde{\omega}(x)} x^{1-\sigma} [\overline{y}(\omega; x)]^{(\sigma-1)/\sigma}\, dG(\omega) + \left[\frac{\sigma}{\sigma-1}\frac{1}{a}\right]^{1-\sigma} [1 - G(\widetilde{\omega}(x))],$$

which pins down the real interest rate ρ/P as a function of x.

(ii) Assume now that $\lambda \geq (\sigma-1)/\sigma$ (no credit rationing). In this situation, all firms produce $\widetilde{y}$ and hence invest $\widetilde{y}/a$ capital units (recall $\kappa < K$). As a result, (gross-)capital demand is given by $\int_0^\infty (\widetilde{y}/a)\, dG(\omega) = (Y/P)a^{\sigma-1}(\rho/P)^{-\sigma}((\sigma-1)/\sigma)^\sigma$. Moreover, since all firms invest $\widetilde{y}/a$, we must have that $K = \widetilde{y}/a$ – which implies $Y/P = aK$ (equation 6). Hence, the equilibrium interest rate is determined by $aKa^{\sigma-1}(\rho/P)^{-\sigma}\left(\frac{\sigma-1}{\sigma}\right)^{\sigma} = K$,which results in

$$\frac{\rho}{P} = a\frac{\sigma-1}{\sigma}.$$

Proof of Proposition 2. To start the proof, we introduce a number of definitions. First, we define $z \equiv P^{\sigma-1}Y$ so that (i) $p(y)$ given in (5) reads $p(y) = z^{1/\sigma}y^{-1/\sigma}$; (ii) we have $x = (\tau/a)z^{1/\sigma}$. Second, it is convenient to introduce $\underline{z}$ which is the value of z that makes $p(a\kappa)$ equal to τ. Hence, we have $\underline{z} = (a\kappa)\tau^{\sigma}$. Thirdly, we write capital demand as a function of z:

$$\begin{aligned} K^D(z) \quad = \quad & \int_0^{\omega_\kappa^I} \frac{1-\tau^2 b/a}{1-\lambda\tau^2 b/a}\omega dG(\omega) + \int_{\omega_\kappa^I}^{\omega_\tau^I} \frac{1-\tau^2}{1-\lambda\tau^2}\omega dG(\omega) + \int_{\omega_\tau^I}^{\widetilde{\omega}} \frac{\overline{y}^I(\omega;z)}{a} dG(\omega) \\ & + \frac{1}{a}z\tau^{\sigma}\left(\frac{\sigma-1}{\sigma}\right)^{\sigma}[1-G(\widetilde{\omega}_I)] + \frac{1}{a}z\tau^{2-\sigma}G(\omega_\tau^I). \end{aligned}$$

Finally, note that $\overline{y}^I(\omega;z)$ is increasing in z and that $\omega_\kappa^I = \omega_\tau^I$ if $z = \underline{z}$.

We now show that – if κ is sufficiently low – $K^D(z) = K$ uniquely pins down z. The first step is to observe that, as z rises from $\underline{z}$ to infinity, $K^D(z)$ monotonically increases (to calculate the derivative note that marginal changes in ω_τ^I and $\widetilde{\omega}$ leave K^D unaffected), where $\lim_{z\to\infty} K^D(z) = \infty$. The second step is to establish that $K^D(\underline{z}) < K$ if κ is sufficiently low. Since the first term in the above expression is negative and – at $z = \underline{z}$ – the second one is zero, we have

$$K^D(\underline{z}) < \int_{\omega_\tau^I}^{\widetilde{\omega}} \frac{\overline{y}^I(\omega;\underline{z})}{a} dG(\omega) + \frac{1}{a}\underline{z}\tau^{\sigma}\left(\frac{\sigma-1}{\sigma}\right)^{\sigma}[1-G(\widetilde{\omega})] + \frac{1}{a}\underline{z}\tau^{2-\sigma}G(\omega_\tau^I).$$

Moreover, using $\underline{z} = (a\kappa)\tau^{\sigma}$ and taking into account that $\overline{y}^I(\omega;z) \leq \widetilde{y} = \underline{z}\tau^{\sigma}\left((\sigma-1)/\sigma\right)^{\sigma}$ gives us

$$K^D(\underline{z}) < \kappa\left(\frac{\tau^2}{\sigma/(\sigma-1)}\right)^{\sigma}[1-G(\omega_\tau^I)] + \kappa\tau^2 G(\omega_\tau^I).$$

Note that the right-hand side (RHS) of the above expression depends only on exogenous parameters (and the distribution of ω). Thus, if $\kappa < K/\max\left\{\left(\tau^2(\sigma-1)/\sigma\right)^{\sigma}, \tau^2\right\}$, we have $K^D(\underline{z}) < K$. Moreover, since $K^D(z)$ monotonically increases in z (and is unbounded), there exists a unique z which satisfies $K^D(z) = K$.

As in the proof of Proposition 1, the final step is to show that Y/P is uniquely pinned down (given that there is a unique z). To do so, we exploit again the CES price index which – in this case – can be written as

$$P^{(1-\sigma)} = \tau^{1-\sigma}G(\omega_\tau^I) + \int_{\omega_\tau^I}^{\widetilde{\omega}} \left[p(\overline{y}^I(\omega;z))\right]^{1-\sigma} dG(\omega) + \left[\frac{\sigma}{\sigma-1}\frac{1}{\tau}\right]^{1-\sigma}[1-G(\widetilde{\omega})].$$

Note that $\overline{y}^I(\omega; z)$ as well as the thresholds ω_τ^I and $\widetilde{\omega}$ are functions of z (and the exogenous parameters of the model). As a result, P – and hence $Y/P = zP^{-\sigma}$ – are uniquely determined.

Proof of Proposition 3. To start with, consider an equilibrium where a positive mass of the poorest entrepreneurs uses the low-productivity technology. Moreover, suppose that a positive fraction of these low-productivity firms are price-constrained. Using an approach similar to the one chosen in Section 4.2, we can derive the credit market equilibrium condition that is relevant for this type of equilibrium:

$$\begin{aligned} K &= \int_0^{\omega_\tau^I} \frac{1-\tau^2 b/a}{1-\lambda\tau^2 b/a}\omega dG(\omega) + \int_{\omega_\tau^I}^{\omega_\kappa^I} \frac{\overline{y}^I(\omega)}{b} dG(\omega) + \int_{\omega_\kappa^I}^{\widetilde{\omega}} \frac{\overline{y}^I(\omega)}{a} dG(\omega) \\ &\quad + \frac{1}{a} Y P^{\sigma-1}\tau^\sigma \left(\frac{\sigma-1}{\sigma}\right)^\sigma [1-G(\widetilde{\omega})] + \frac{1}{a} Y P^{\sigma-1}\tau^{2-\sigma} G(\omega_\tau^I). \end{aligned}$$

In what follows, we will use the definition $\upsilon \equiv YP^{\sigma-1}\tau^\sigma$. Applying this definition, and using the fact that $\rho = a/\tau$, the function $\overline{y}^I(\omega)$ in the above equation is implicitly defined by

$$\overline{y}^I(\omega) = \begin{cases} b\omega + \lambda \left[\overline{y}^I(\omega)\right]^{\frac{\sigma-1}{\sigma}} \upsilon^{\frac{1}{\sigma}} b/a & : \quad \omega_\tau^I \le \omega < \omega_\kappa^I \\ a\omega + \lambda \left[\overline{y}^I(\omega)\right]^{\frac{\sigma-1}{\sigma}} \upsilon^{\frac{1}{\sigma}} & : \quad \omega_\tau^I < \omega_\kappa^I \le \omega \end{cases},$$

where the level of wealth at which the credit constraint becomes binding, ω_κ^I, is given by $\omega_\kappa^I = \kappa(1-\lambda(\upsilon/a\kappa)^{1/\sigma})$. The level of wealth at which the price constraint becomes relevant, ω_τ^I, is given by $\omega_\tau^I = P^{\sigma-1}Y\tau^{-\sigma}\left(b^{-1}-\lambda\tau/\rho\right)$. Using again $\rho = a/\tau$, we get $\omega_\tau^I = P^{\sigma-1}Y\tau^{-\sigma}\left(b^{-1}-\lambda\tau^2/a\right)$ which, in turn, can be rewritten as $\omega_\tau^I = \upsilon\tau^{-2\sigma}\left(b^{-1}-\lambda\tau^2/a\right)$. In this context, note further that $\widetilde{y} = \upsilon\left((\sigma-1)/\sigma\right)^\sigma$ and, as usual, $\widetilde{\omega} = (1-\lambda\sigma/(\sigma-1))\,\widetilde{y}/a$. Finally, we can rewrite the above credit market equilibrium condition as

$$\begin{aligned} aK &= \int_0^{\omega_\tau^I} a\frac{1-\tau^2 b/a}{1-\lambda\tau^2 b/a}\omega dG(\omega) + \int_{\omega_\tau^I}^{\omega_\kappa^I} a\frac{\overline{y}^I(\omega)}{b} dG(\omega) + \int_{\omega_\kappa^I}^{\widetilde{\omega}} \overline{y}^I(\omega) dG(\omega) \\ &\quad + \upsilon\left(\frac{\sigma-1}{\sigma}\right)^\sigma [1-G(\widetilde{\omega})] + \upsilon\tau^{2(1-\sigma)} G(\omega_\tau^I). \end{aligned} \tag{20}$$

This is convenient as the endogenous variables enter expression (20) only through υ. The same holds for the aggregate real output, Y/P (which is equivalent to welfare, U):

$$\begin{aligned} (Y/P)^{(\sigma-1)/\sigma} &= U^{(\sigma-1)/\sigma} = \upsilon^{(\sigma-1)/\sigma}\tau^{2(1-\sigma)} G(\omega_\tau^I) + \int_{\omega_\tau^I}^{\widetilde{\omega}} \overline{y}^I(\omega)^{(\sigma-1)/\sigma} dG(\omega) \\ &\quad + \upsilon^{(\sigma-1)/\sigma}\left(\frac{\sigma-1}{\sigma}\right)^{\sigma-1} [1-G(\widetilde{\omega})]. \end{aligned}$$

The change in the aggregate real output (or welfare) in response to a change in trade costs can be decomposed into two parts. There is a direct as well as a general-equilibrium effect:

$$\frac{dU}{d\tau} = \frac{\partial U}{\partial \tau} + \frac{\partial U}{\partial v}\frac{dv}{d\tau}.$$

Taking into account that $\overline{y}^I(\omega_\tau^I) = v\tau^{-2\sigma}$, the two partial derivatives are given by

$$\frac{\partial U}{\partial \tau} = -2(\sigma-1)v^{(\sigma-1)/\sigma}\tau^{2(1-\sigma)-1}G(\omega_\tau^I) < 0$$

and

$$\begin{aligned}\frac{\partial U}{\partial v} &= \frac{\sigma-1}{\sigma}v^{-1/\sigma}\tau^{2(1-\sigma)}G(\omega_\tau^I) + \frac{\sigma-1}{\sigma}\int\limits_{\omega_\tau^I}^{\widetilde{\omega}} \overline{y}^I(\omega)^{-1/\sigma}\frac{\partial \overline{y}^I(\omega)}{\partial v}dG(\omega) \\ &\quad + (b^{(\sigma-1)/\sigma} - a^{(\sigma-1)/\sigma})\kappa^{(\sigma-1)/\sigma}\frac{\partial \omega_\kappa^I}{\partial v} + v^{-1/\sigma}\left(\frac{\sigma-1}{\sigma}\right)^\sigma [1-G(\widetilde{\omega})] > 0,\end{aligned}$$

where the latter derivative is unambiguously positive since $\partial\overline{y}^I(\omega)/\partial v > 0$ and $\partial\omega_\kappa^I/\partial v < 0$. The derivative $dv/d\tau$, on the other hand, can be found by implicitly differentiating the credit market equilibrium condition (20):

$$\frac{dv}{d\tau} = -\frac{2(\lambda-1)\int\limits_0^{\omega_\tau^I}\frac{b\tau}{(1-\lambda\tau^2 b/a)^2}\omega dG(\omega) + 2(1-\sigma)v\tau^{2(1-\sigma)-1}G(\omega_\tau^I)}{\int\limits_{\omega_\tau^I}^{\omega_\kappa^I}\frac{a}{b}\frac{\partial}{\partial v}\overline{y}^I(\omega)dG(\omega) + \int\limits_{\omega_\kappa^I}^{\widetilde{\omega}}\frac{\partial}{\partial v}\overline{y}^I(\omega)dG(\omega) + \left(\frac{\sigma-1}{\sigma}\right)^\sigma[1-G(\widetilde{\omega})] + \tau^{2(1-\sigma)}G(\omega_\tau^I)} > 0.$$

We now move on the final step of the proof which is to determine the sign of $dU/d\tau$ at $\tau = \tau^{AT}$. At this point, the constrained-optimal price of the poorest entrepreneurs (i.e, those with $\omega = 0$) is exactly τ – which implies $\omega_\tau^I = 0$. As a result, we immediately get $\partial U/\partial\tau|_{\omega_\tau^I=0} = 0$ and $\partial U/\partial v|_{\omega_\tau^I=0} > 0$. In order to find the sign of $dv/d\tau|_{\omega_\tau^I=0}$, note that

$$\lim_{\tau\to\tau^{AB}}\int\limits_0^{\omega_{\tau I}}\frac{b\tau}{(1-\lambda\tau^2 b/a)^2}\omega dG(\omega) = -\frac{v}{4}\left(\frac{a}{b\lambda}\right)^{\sigma-1}g(\omega_\tau^I)\frac{\partial\omega_\tau^I}{\partial\tau} > 0$$

and hence $dv/d\tau|_{\omega_\tau^I=0} > 0$. As a result, we conclude that

$$\left.\frac{dU}{d\tau}\right|_{\omega_\tau^I=0} = \left.\frac{d(Y/P)}{d\tau}\right|_{\omega_\tau^I=0} > 0.$$

Proof of Lemma 1. The proof is most easily provided by a graphical argument. Consider the case $\omega < \omega_\kappa$. Whereas the left-hand side (LHS) of equation (10) is linear in $\overline{y}$ starting from zero, the RHS starts at ω and its slope reaches zero as $\overline{y}$ grows very large. Thus, $\overline{y}$ is uniquely determined. An increase in ω shifts up the RHS such that the new intersection of the LHS and the RHS lies to the right of the old one. The analogous argument holds true for $\omega \geq \omega_\kappa$. Finally, the definition of ω_κ implies that $\overline{y}(\omega_\kappa) = a\kappa > b\kappa > \lim_{\omega\to\omega_\kappa^-}\overline{y}(\omega)$. Hence, $\overline{y}(\omega)$ is strictly monotonic in ω.

Proof of Lemma 2. Suppose first $\lambda < (\sigma-1)/\sigma$ so that $\widetilde{\omega} > 0$. Under these circumstances, entrepreneurs with $\omega \in [\omega_\kappa, \widetilde{\omega})$ have access to the efficient technology but their maximum output, $\overline{y}(\omega)$, falls short of $\widetilde{y}$. But this means that, when producing $\overline{y}(\omega)$, the marginal revenue still exceeds marginal costs. Thus, producing the maximum quantity is indeed optimal. On the other hand, entrepreneurs with $\omega \geq \widetilde{\omega}$ will not go beyond $\widetilde{y}$ because, if they chose a higher level, the marginal revenue would be lower than the cost of borrowing (if $\omega < \widetilde{y}/a$) or the income from lending (if $\omega \geq \widetilde{y}/a$). The second part of the claim is obvious and does not require further elaboration.

Proof of Lemma 3. To establish the claim, we show that the marginal revenue at the output level $b\kappa$ is not smaller than the marginal cost associated with the less efficient technology, ρ/b. This implies that for all $y < b\kappa$ marginal revenues strictly exceed marginal costs so that all entrepreneurs with $\omega < \omega_\kappa$ strictly prefer the maximum firm output. The marginal revenue at $y = b\kappa$ is given by $((\sigma-1)/\sigma)P^{(\sigma-1)/\sigma}Y^{1/\sigma}(b\kappa)^{-1/\sigma}$, and so what we have to prove is

$$\begin{aligned} \frac{\sigma-1}{\sigma}P^{(\sigma-1)/\sigma}Y^{1/\sigma}(b\kappa)^{-1/\sigma} &\geq \frac{\rho}{b} \\ \frac{P^{(\sigma-1)/\sigma}Y^{1/\sigma}}{\rho} &\geq \frac{\sigma}{\sigma-1}\frac{1}{b}(b\kappa)^{1/\sigma}. \end{aligned} \tag{21}$$

In order to do so, we will establish a lower bound for the LHS of the second line in the above expression. Note that $((\sigma-1)/\sigma)P^{(\sigma-1)/\sigma}Y^{1/\sigma}\widetilde{y}^{-1/\sigma} = \rho/a$. Notice further that, in an equilibrium, we must have that $\widetilde{y}/a \geq K$ since there are no firms operating at a higher scale of investment. Thus, we have $((\sigma-1)/\sigma)P^{(\sigma-1)/\sigma}Y^{1/\sigma}(aK)^{-1/\sigma} \geq \rho/a$ or, equivalently,

$$\frac{P^{(\sigma-1)/\sigma}Y^{1/\sigma}}{\rho} \geq \frac{\sigma}{\sigma-1}\frac{1}{a}(aK)^{1/\sigma}.$$

It is now straightforward to check that, due to the parameter restriction (R1), $(1/a)(aK)^{1/\sigma} > (1/b)(b\kappa)^{1/\sigma}$. But this means that (21) must be satisfied.

Tables

***Table* 1** – Motivating evidence: Tariff protection and access to finance

	Substantial tariff reduction	No substantial tariff reduction	Substantial tariff reduction	No substantial tariff reduction	Substantial tariff reduction	No substantial tariff reduction
	(1)	(2)	(3)	(4)	(5)	(6)
	All firms		Smaller firms (≤ 100 employees)		Larger firms (> 100 employees)	
Share of firms with *FIN_CONS* = 1 in 2006	0.080	0.123	0.083	0.129	0.071	0.1
Share of firms with *FIN_CONS* = 1 in 2010	0.123	0.113	0.132	0.125	0.095	0.057
Difference estimator (*ΔFIN_CONS*)	0.043	-0.010	0.049	-0.004	0.024	-0.043
	(0.200)	(0.654)	(0.215)	(0.904)	(0.697)	(0.350)
Number of observations	163	381	121	311	42	70
DiD estimator :						
- Country dummies included	0.111**		0.135***		0.006	
	(0.015)		(0.003)		(0.965)	
- Country and industry dummies included	0.125**		0.162**		0.034	
	(0.032)		(0.012)		(0.823)	
Number of observations	544		432		112	

Note: *p* -values in parentheses; *** and ** denote significance at the 1% and 5% levels, respectively; the *p* -values are based on *t* -tests with unequal variances (difference estimator) or robust standard errors (difference-in-difference estimator). A substantial tariff reduction is a tariff cut of 0.5 percentage points or more. The category "smaller firms" includes firms which are classified by the WBES as either small (less than 20 employees) or medium-sized (less than 100, but at least 20, employees).

***Table* 2** – Quantitative analysis: Trade costs, aggregate real output, and the allocation of capital

	a/b = 1.33		*a/b* = 1.50		*a/b* = 1.77	
	(1)	(2)	(3)	(4)	(5)	(6)
Trade costs, τ	*Y/P*	β	*Y/P*	β	*Y/P*	β
1.00	1.0000	0.00	1.0000	0.00	1.0000	0.00
1.05	0.9606	0.00	0.9606	0.00	0.9606	0.00
1.10	0.9290	0.00	0.9290	0.00	0.9290	0.00
1.15	0.9049	0.00	0.9049	0.00	0.9049	0.00
1.20	0.9036	20.56	0.8890	0.00	0.8890	0.00
1.25	0.8470	17.29	0.8249	16.82	0.8182	0.00
1.30	0.8142	13.49	0.7927	13.08	0.7748	0.00
1.35	0.8396	9.05	0.8218	8.75	0.8021	8.42
1.40	0.8952	3.84	0.8859	3.70	0.8757	3.55
1.45	0.9345	0.00	0.9345	0.00	0.9345	0.00

Note: *Y/P* and β refer to the aggregate real output and the share of capital invested in low-productivity firms, respectively. The table shows simulations for three different (*a/b*)-ratios, stated in the first row. The distribution of capital is assumed to be Pareto (with an inverted Pareto coefficient of 1.81). The remaining parameter values are as follows: λ = 0.17, σ = 3, κ = 0.85, and K = 1. The choice of parameter values is discussed in Subsection 4.3.2. The simulations were carried out in Mathematica; we programmed a routine which performs the numerical integration of an implicitly defined function.

Figures

***Figure* 1** – Maximum firm output

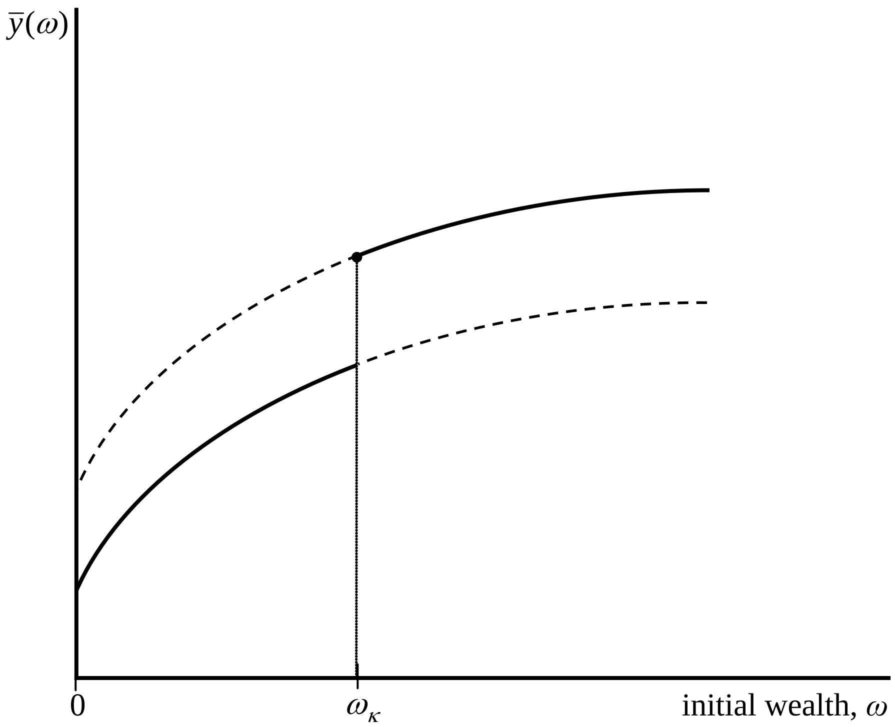

***Figure* 2** – Equilibrium firm outputs (assuming $\lambda < (\sigma - 1)/\sigma$)

a. Some firms use the less productive technology

b. All firms use the more productive technology

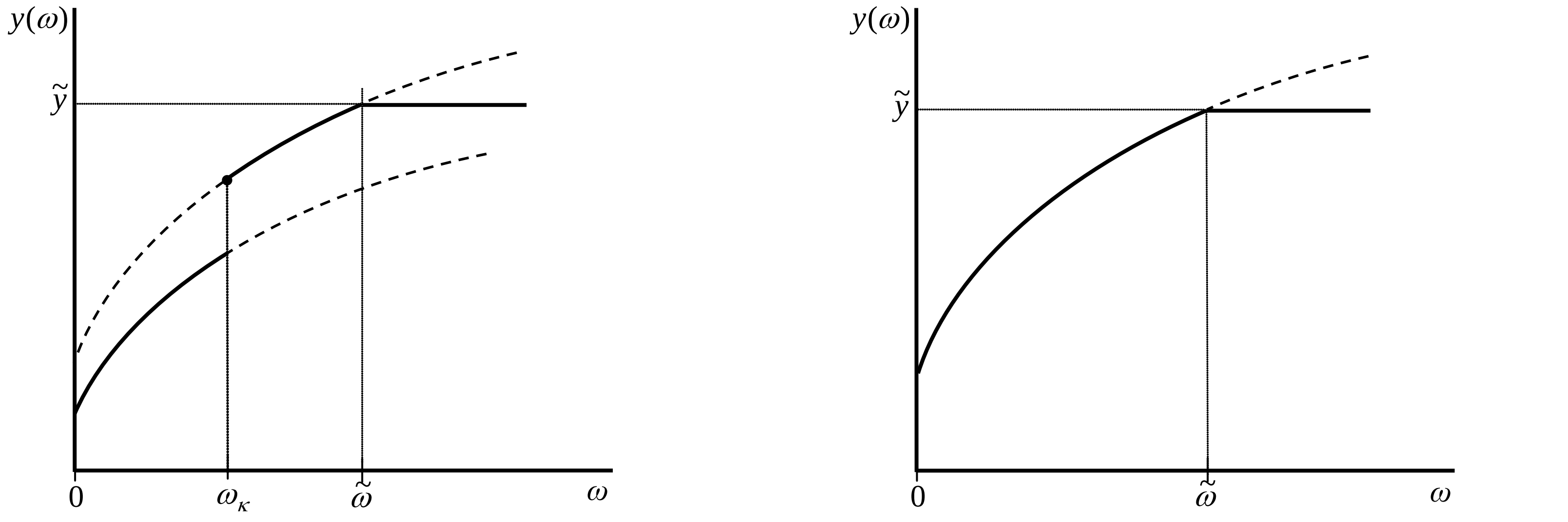

***Figure* 3** – Aggregate gross capital demand (assuming $\lambda < (\sigma - 1)/\sigma$)