Globalization and Productivity in the Developing World*

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Abstract

We explore the impact of international trade in a monopolistically competitive economy that encompasses technology choice and an endogenous distribution of mark-ups due to credit frictions. We show that in such an environment a gradual opening of trade (i) may – but not necessarily must – have a negative impact on productivity and overall output; (ii) is bound to increase the polarization of the income distribution. The reason is that the pro-competitive effects of trade reduce mark-ups and hence the borrowing capacity of less affluent entrepreneurs. As a result, smaller firms – while not driven out of the market – may be forced to switch to a less productive technology. Our framework matches several salient patterns in the recent evidence on the impact of trade in developing countries.

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1 Introduction

How and through what channels does international trade affect productivity and overall output in an economy? The recent literature has emphasized 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 upgrade technology (e.g., Lileeva and Trefler, 2010; Bustos, 2011). This paper, in contrast, identifies a number of channels through which intensified foreign competition may have a negative effect on productivity and output. These channels only emerge in presence of asset inequality and significant credit market frictions, i.e., under circumstances we encounter throughout the developing world (see, e.g., Banerjee and Duflo, 2010). Our analysis thus provides new insights into why the empirical literature does not find unambiguously positive effects of international trade on (various measures of) economic performance in less advanced economies.

We explore the impact of trade in a monopolistically competitive model (à la Dixit and Stiglitz, 1977) that features an *endogenous distribution of mark-ups* due to credit market frictions. It is assumed that loan repayment is imperfectly enforceable so that an entrepreneur's borrowing capacity depends on her private wealth. As a result, less affluent entrepreneurs are forced to run small firms – and thus charge high 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 surge 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 unambiguously boosts economic performance as the availability of scarce goods improves 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*. An intermediate reduction of trade barriers reduces the maximum amount smaller firms can borrow and invest. As a result, some of these smaller firms are forced to switch to less productive (i.e., "traditional") technologies. Yet, because there is still some protection, even these firms are not forced to leave the market – which means that, paradoxically, the 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 the 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. These changes in the use of technologies and firm sizes have a clear-cut impact on the income distribution: While the owners of small firms lose, the most affluent entrepreneurs win substantially – which implies a further polarization of the income distribution.

The result that the aggregate output (or welfare) might fall in response to a gradual decline in trade barriers is an illustration of the theorem of the second best (discussed by, e.g., Bhagwati, 1971). 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. From this perspective, the contribution of the present paper is to show that credit market frictions exactly imply such harmful adjustments. Lower trade barriers tighten the borrowing constraints faced by smaller firms – and hence force them to invest less and use less efficient technologies. As a result, the extent of under-production by these firms increases. At the same time, absorbing capital no longer employed by the small firms, large companies increase their output – which means even more over-production. It is further interesting to note that, although the distribution of firm outputs gets more polarized, the mark-ups across firms become more similar. The conclusion is thus that an opening of trade can be harmful even if it brings a completely symmetric fall in trade barriers that leads to a reduction in both the average level of mark-ups as well as the dispersion of mark-ups.

Our model offers a coherent perspective on a growing body of empirical evidence on the effects of trade in developing countries. 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 (see, e.g., Kehoe and Ruhl, 2010).[1] The model further features a genuine mechanism

[1] This empirical pattern is also consistent with anecdotal evidence from East Asia. As pointed out by, e.g., Stiglitz and Charlton (2005) or Rodrik (2010), many of the East Asian miracle countries did not follow free-trade policies but used to protect selected industries from import competition.

which makes the richest segment of society benefit disproportionally – and hence may explain why liberalizing trade went hand in hand with surging top income shares in several developing countries (e.g., in India in the early 1990s). At a more disaggregate level, our model matches surprising observations regarding resource misallocation and firm productivity. Among them are findings from India which suggest that allocative efficiency deteriorated sharply (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]

This paper contributes to the literature on international trade and heterogeneous firms. Yet, focusing on the role of credit market frictions and wealth inequality, 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 trade and economic performance. We further add to a growing literature on international trade and finance. Papers in this literature – like the ones by Amiti and Weinstein (2011), Feenstra et al. (2011), or Manova (2012) – primarily explore how financial frictions constrain export-oriented firms and distort aggregate export flows. Relying on a general equilibrium framework, our paper is more interested in how international trade affects borrowing conditions and technology choices of smaller (and not necessarily export-oriented) firms.[3] By analyzing how trade affects the distribution of mark-ups, our analysis also connects with recent work by Foellmi and Oechslin (2010) and Epifani and Gancia (2011). While the former paper focuses on the implications for income inequality, the latter one shows that the pro-competitive effects of trade can actually reduce welfare when they increase the dispersion of mark-ups. This paper, in contrast, shows that – when there are credit market imperfections – international trade may reduce welfare even if it leads to a more even distribution of mark-ups.

More broadly, our analysis is related to yet another strand of literature that explores how distortions (e.g., Hsieh and Klenow, 2009) or 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

[2] There is, however, strong evidence from India in support of an alternative mechanism, the "input channel". Goldberg et al. (2009) document that the fall in input tariffs led to an increase in the number and volume of input factors imported from abroad. The better availability of input factors, in turn, translated into higher levels of productivity (see, e.g., Topalova and Khandelwal, 2011; Nataraj, 2011).

[3] Early papers which rely on general-equilibrium models include Banerjee and Newman (2004) and Matsuyama (2005). These papers elaborate variants of the Ricardo-Viner model and do not address how the pro-competitive effects of trade affect markups and thus access to credit and firms' technology choices.

with wealth 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. We share this prime focus with other recent work by Kambourov (2009), Coşar et al. (2010), Helpman et al. (2010), or McMillan and Rodrik (2011) which, however, explore the role of labor market frictions or labor flows.

The rest of this paper is organized as follows. The next section presents and solves the closed-economy model. In Section 3, we describe the effects of opening up to international trade – with special emphasis on an intermediate-openness case. Relying on simulations, the section further gives a systematic overview of the adjustments associated with a continuous decrease in trade barriers from prohibitive levels to zero. Section 4 discusses the analytical and numerical results and links them to the empirical literature. It also includes a brief discussion of policy implications. Section 5, finally, concludes.

2 The Closed Economy

2.1 Endowments, Technologies, and Preferences

Assumptions. The economy 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 owns a specific skill (or technological know-how) that makes him a monopoly supplier of a single differentiated good. All goods are produced with a simple technology that requires capital as the only input into production. The technology, however, is characterized by a non-convexity. In particular, its productivity is relatively low if the investment falls short of a critical threshold. In formal terms, we impose

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

where y_i and k_i denote, respectively, output and capital and κ refers to the critical scale of investment. 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 mirror the idea that opening up exposes firms to more vigorous competition and hence may affect technology choices (especially, as is discussed below, in the presence of credit market imperfections). Of course, the idea that exposure to international trade enhances competition is not restricted to poor economies. Yet, firms in low-income countries might be particularly prone to losing market power because they tend to produce less innovative goods (see, e.g., Acemoglu and Zilibotti, 2001) and since the market structure in these places is often monopolistic (see, e.g., UNCTAD, 2006).

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 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.

2.2 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 and the associated problem of moral hazard are in fact important phenomena in many developing economies. It is, for example, 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.[4] 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

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

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

$$\overline{y} = \begin{cases} b\left(\omega + \lambda x \overline{y}^{(\sigma-1)/\sigma}\right) & : \quad \omega < \omega_\kappa \\ a\left(\omega + \lambda x \overline{y}^{(\sigma-1)/\sigma}\right) & : \quad \omega \geq \omega_\kappa \end{cases} \tag{9}$$

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 I. ■

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

[4]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.

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 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.

2.3 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

$$x \geq \frac{1}{a}\frac{\sigma}{\sigma-1}(a\kappa)^{1/\sigma}, \tag{10}$$

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

$$\widetilde{y} = \left(ax\frac{\sigma-1}{\sigma}\right)^{\sigma} \quad \text{and} \quad \widetilde{\omega} = \left(1-\lambda\frac{\sigma}{\sigma-1}\right)\frac{\widetilde{y}}{a}, \tag{11}$$

where $\widetilde{y}/a \geq \kappa$ due to (10).

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 (11), $\lambda < (\sigma-1)/\sigma$ 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 I. ■

$\omega < \omega_\kappa$. 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 I. ■

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

$$y(\omega) = \begin{cases} \overline{y}(\omega) & : \quad \omega < \widetilde{\omega} \\ \widetilde{y} & : \quad \omega \geq \widetilde{\omega} \end{cases}, \tag{12}$$

where $\overline{y}(\omega)$ is implicitly determined by (9) and $\widetilde{y}$ is given in (11). 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 (12). 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.

2.4 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,

$$K^D(x) = \int_0^{\omega_\kappa} \frac{\overline{y}(\omega; x)}{b} dG(\omega) + \int_{\omega_\kappa}^{\widetilde{\omega}} \frac{\overline{y}(\omega; x)}{a} dG(\omega) + \int_{\widetilde{\omega}}^{\infty} \frac{\widetilde{y}(x)}{a} dG(\omega), \tag{13}$$

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 are 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 I. ■

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 (10), on which both Lemma 2 and 3 rely, is indeed satisfied.[5]

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).

3 Integrating into the World Economy

This section explores how a reduction in trade barriers affects the use of technologies, aggregate output, and the income distribution in the home economy. The home economy – which is taken to represent a developing country – will be called the "South". The rest of the world (i.e., the South's trading partner) is referred to as the "North" and represents an advanced economy.

3.1 Assumptions

Trade barriers. 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 due to the existence of per-unit trade costs (which may be composed of tariffs and transport costs). In particular, 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.

[5] 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 $\rho/P = a(\sigma - 1)/\sigma$).

The North. The North differs from the South in that its markets function perfectly. In particular, the northern credit market is frictionless so that there are no credit constraints. Moreover, in the North, each variety is produced by a large number of firms so that the northern goods market is perfectly competitive. 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, respectively). Moreover, for the sake of simplicity, the North produces the same spectrum of goods as the South does.[6] Thus, following Banerjee and Newman (2004) and Foellmi and Oechslin (2010), poor and rich countries are not distinguished in terms of technology or endowments but according to how well important markets work.

Given our assumptions regarding markets and technologies, it is immediately clear 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 normalize the northern price level to one. Obviously, this normalization implies that all goods prices in the North (as well as the northern marginal cost) are also equal to one.

3.2 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 (in terms of the numéraire).

3.2.1 Characterizing the Equilibrium

Intermediate per-unit trade costs. 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,

$$p(a\kappa) > \tau > p(\widetilde{y}), \tag{14}$$

where $p(y)$ and $\widetilde{y}$ are defined in (5) and (11), respectively.

[6] It may be more natural to assume that the North produces a larger number of varieties than the South. Yet, doing so would increase the gains from trade but not change the qualitative implications otherwise.

Changes relative to the closed economy. Allowing for international trade leads to two formal adjustments (relative to the closed-economy variant of the model). 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

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

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.[7] A straightforward derivation of the two thresholds in (9') gives

$$\omega_\kappa^I = \left(1 - \frac{\lambda a\tau}{\rho}\right)\kappa \ \text{ and } \ \omega_\tau^I = \left(1 - \frac{\lambda a\tau}{\rho}\right)(Y/P)(\tau/P)^{-\sigma}/a. \tag{15}$$

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 our framework is static, trade needs to be balanced). 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 $1/a$ units of capital) generates an income of $1/\tau$, the domestic borrowing rate must be a/τ. If the equilibrium borrowing rate were higher, nobody would export since lending would generate a higher return; on the other hand, if the borrowing rate 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.

Parameters. We now work towards a description of the parameter constellations under which this equilibrium can occur. The first step is to note that using $\rho = a/\tau$ in (15) yields

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

Thus, for a positive mass of price-constrained entrepreneurs to exist, we need $\tau^2 < 1/\lambda$. Secondly, observe that imposing condition (14) leads to a lower bound on τ. Using both $\rho = a/\tau$ and the definition of $\widetilde{y}$ in expression (5) gives $p(\widetilde{y}) = (1/\tau)(\sigma/(\sigma-1))$. As a result, $\tau > p(\widetilde{y})$ implies $\tau^2 > (\sigma/(\sigma-1))$. Thus, in sum, what we necessarily must have is

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

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

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

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

3.2.2 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 income is uniquely pinned down.

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, one has to deduct the value of the domestic production. Moreover, in a balanced trade equilibrium, 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 expression on the right-hand side of the first line gives total expenditures on all goods that are imported (i.e., goods produced by entrepreneurs with $\omega < \omega_\tau^I$); the first expression of the second line is the total value of the goods produced by domestic entrepreneurs with $\omega < \omega_\kappa^I$ (i.e., by low-productivity firms); the second expression of the second line gives the total value of the goods produced by domestic entrepreneurs with $\omega_\kappa^I \leq \omega < \omega_\tau^I$ (i.e., by high-productivity firms with an output that is too small to meet the demand at price τ).

Resource constraint. To find an expression for (gross-)capital demand, note first that from (11) 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

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

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

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 (and middle-class) 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 I. ■

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 in a minority. Obviously, though, the mechanism behind these implications is 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.

3.2.3 Comparative-Static Properties

Trade barriers and average productivity. A first important comparative-static result is that reducing trade barriers (i.e., a fall in τ) increases the number of firms which use the low-productivity technology: Since the critical threshold in this regard, $\omega_\kappa^I = \left(1-\lambda\tau^2\right)\kappa$, increases as τ falls, it must be the case that $G(\omega_\kappa^I)$ is higher when τ is lower. This is an intuitive finding. 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, profit margins shrink – which means 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 minimum investment threshold.

A higher number of low-productivity firms, however, does not necessarily mean that a larger fraction of the capital stock is allocated to less efficient technologies (which would imply a decline in capital-weighted average firm productivity). Since the low-productivity firms that have already existed before invest less, the impact on average productivity is ambiguous. To see this, note that the share of total capital invested in low-productivity firms is

$$\frac{1}{1-\lambda\tau^2 b/a}\int_0^{(1-\lambda\tau^2)\kappa} \omega dG(\omega)/K.$$

The impact of lower trade barriers on the above expression 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 barriers implies that a larger fraction of the capital stock is used less productively so that capital-weighted average firm productivity (and, as the discussion below will show, potentially aggregate real output) falls.

Trade barriers and the distribution. The second interesting finding relates to the income distribution. Given that the equilibrium discussed in Proposition 2 prevails, a reduction in trade barriers amplifies the polarization of the income distribution. To see this, note that the nominal rate of return in unconstrained firms is a/τ whereas the rate 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 $(1-\lambda)\tau a/(1-\lambda\tau^2)$ if the high-productivity technology is used. Thus, lowering τ increases nominal incomes in the higher parts of the distribution and diminishes those at the bottom, as illustrated by Figure 4 which shows the impact of a fall in τ on $m(\omega)$, the nominal income as a function of initial wealth. The figure highlights that higher incomes gain disproportionally.

Figure 4 here

To summarize, the nominal incomes of the poor fall because of lower output prices and a higher cost of borrowing. The rich gain because the return from exporting goods (or, alternatively, from lending to less affluent entrepreneurs) increases as τ declines.

The discussion so far suggests that, if trade barriers are reduced from an intermediate level, there is a *polarization effect*: Some medium-sized firms will have to downsize and to turn to the low-productivity technology while some of the big high-productivity firms grow even bigger. As a result, a pre-existing polar structure of the industry (and the income distribution) becomes even more pronounced. Moreover, reflecting these changes, the imports of varieties produced by smaller firms increase strongly, (as prices and domestic production of these varieties fall at the same time) while the exports by large companies increase. This *replacement* of domestic output with imports is a potential second source of inefficiency, as the economy might spend more resources on transportation costs.

Note, however, that these adjustments – even if they implied a fall in average productivity or an increase in aggregate trade costs – do not necessarily lead to a decline in the aggregate real output (or in the real incomes of the less affluent entrepreneurs). The reason is an improvement in consumption possibilities: Lower trade barriers reduce prices and improve the availability of goods that are scarce in the domestic economy – which could overcompensate a less efficient use of factors or a rise in aggregate trade costs. The following section, which turns to a numerical example, will also allow us to explore the relative strength of these different effects.

3.3 From Autarky to Full Integration

3.3.1 A Two-Point Distribution

We now take a broader look at the relationship between trade barriers and macroeconomic outcomes and analyze all possible equilibrium constellations. In particular, we explore the changes to the aggregate real output (or, equivalently, the aggregate real income), individual real incomes, and the income distribution as trade costs continuously decrease from very high levels to zero. To do so, we impose a two-point endowment distribution. This assumption, in combination with the credit market friction, implies a simple bimodal size-distribution of firms, a feature that appears to be typical for developing countries (see, e.g., Tybout, 2000); moreover, it allows us to obtain closed-form solutions. Specifically, we assume that a fraction β of entrepreneurs are "poor" (P), and the capital endowment of these agents is given by $\omega_P = \theta K$, where $\theta < 1$. The remaining entrepreneurs, the "rich" (R), are endowed with $\omega_R = (1 - \beta\theta)K/(1 - \beta)$ capital units (so that the aggregate endowment is K).

The full analytical characterization of the two-group example is given in Appendix II, while a numerical example is discussed following paragraph. Note that there are 2×2 possible equilibrium constellations under which international trade occurs: (i) either only the poor (τP) or all entrepreneurs (τE) are price-constrained; (ii) either only the rich (aR) or all entrepreneurs (aE) use the high-productivity technology. No trade occurs if the poor entrepreneurs are not price-constrained (which means that the economy is in the autarky equilibrium).

3.3.2 Numerical Example

Trade barriers and aggregate output. Considering a numerical example is a tractable way of exploring how a continuous fall in trade costs affects the economy. The parameter values chosen for this exercise are given in Figure 5 which shows aggregate real output, Y/P, as a function of τ. The pattern does not depend on the particular parameter values chosen (for changes in λ see Figure 8 below), but we chose the inequality measures in a way that the Gini coefficient of wealth endowments $\beta(1-\theta)$ takes on a value of 0.32. The relationship between the two variables is non-monotonic, suggesting that the relative strength of the different effects change systematically as τ declines. To see this, suppose first that $\tau > 1.48$. Then, according to condition (19) derived in Appendix II, even the poor entrepreneurs are not price-constrained (and are able to use the high-productivity technology). Thus, as long as $\tau > 1.48$, we are in an autarky equilibrium and a reduction in trade costs has no impact on the economy. This is no longer true, however, as soon as τ reaches 1.48. From this point on, a further continuous fall in trade costs pushes the economy successively through the three equilibrium constellations $(\tau P, aE)$, $(\tau P, aR)$, and $(\tau E, aR)$.

Figure 5 here

To examine the non-monotonic relationship between Y/P and τ in a systematic way, we first take as given the firms' technology choices. Even then, though, trade has two opposing effects. On the one hand, consumption possibilities improve: All other things being equal, the decrease in the prices of the most expensive goods lifts aggregate output since these goods are now consumed in higher quantities. On the other hand, lower prices force the price-constrained firms to produce less, and this fall in domestic production must be compensated through higher imports. As a result, the economy spends more resources on transportation. In other words, a fall in τ leads to a partial replacement of domestic output with costly imports from the North. Figure 5 illustrates that this negative *replacement effect* dominates at higher values of τ so that the real output decreases (even if there is no impact on the use of technologies).[8] Only when τ is sufficiently low, the positive effect on consumption possibilities dominates – and real output increases as τ declines. Finally, with fully integrated markets ($\tau = 1$), all monopolistic distortions vanish and the first-best utility level is achieved.

[8] 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.

A further negative effect on aggregate output becomes visible in the discontinuous decline at $\tau = 1.29$. This is the polarization effect discussed in the previous section: As soon as τ falls below the upper bound, $((1 - \theta K/\kappa)/\lambda)^{1/2} \simeq 1.29$, the capital endowment of the poor agents, θK, falls short of ω_κ^I so that the high-productivity technology is no longer available to them. Yet, switching to the low-productivity technology is still more profitable than becoming a lender, and so the poor agents prefer to remain entrepreneurs.[9] This changes when τ reaches $(a/b)^{1/2} \simeq 1.12$, i.e., as soon as competition becomes sufficiently tough. At that point, the poor agents decide to give up their business and become lenders instead. Obviously, this is yet another manifestation of the selection effect highlighted by, e.g., Melitz (2003). To sum up, aggregate output may fall below the autarky level for "intermediate" levels of trade costs. A full integration, however, necessarily lifts the output above the autarky level.

Figure 6 here

Trade barriers and the distribution. We now explore how a decline in trade costs affects group-specific real incomes and the income distribution (as measured by the income ratio $m_R/m_P = U_R/U_P$). Figure 6 illustrates the relationship between trade costs and the income ratio for the same parameter values as above. Apparently, lower trade costs go together with a higher income ratio. There are two forces behind this increase. On the one hand, inequality goes up because the poor agents are exposed to negative effects: They face a higher borrowing cost since $\rho = a/\tau$ is a negative function of τ (the poor are borrowers unless $\tau \leq (a/b)^{1/2}$); moreover, this direct effect is amplified by the fact that a higher borrowing cost (and lower prices) imply a weaker borrowing capacity. Panel a. of Figure 7 illustrates that these negative effects may be sufficiently strong to make the poor agents worse off in absolute terms.

Figure 7 here

On the other hand, as illustrated in Panel b. of Figure 7, inequality raises because the rich entrepreneurs uniformly gain from lower trade costs (with the exception of levels of τ which make the poor use the low-productivity technology). Overall, this means that there is strong increase in inequality as τ falls from very high levels to zero.

Figure 8 here

[9] Note that the jump is an artefact of the discrete two-group distribution, with a continuous distribution there would be a gradual increase in entrepreneurs relying on the inefficient technology as τ shrinks.

Different degrees of credit market frictions. Figure 8, finally, illustrates the trade cost-output relationship for two different degrees of financial frictions, $\lambda = 0.2$ (as above) and $\lambda = 0.15$. As predicted by the model, we see that the range of trade costs which leads to the use of the less-productive technology is broader if the friction is stronger (i.e., if $\lambda = 0.15$).

4 Discussion

This section relates our findings to the recent empirical literature on the effects of international trade in developing countries and discusses some policy implications.

4.1 The Model and the Evidence

Cross-country evidence. Notwithstanding the existing trade-and-heterogeneous-firms literature (e.g., Bernard et al., 2003; Melitz, 2003; Melitz and Ottaviano, 2008), we find that liberalizing trade can have a non-monotonic impact on average productivity and real output (or welfare): If credit markets are imperfect, a partial liberalization may be detrimental; a full liberalization, however, has a clear positive impact. At the same time, even if a partial liberalization reduced the real output, the rich see their incomes go up (with the gain increasing in wealth even in relative terms) while the poorer entrepreneurs face steep falls. As a result, the distribution of incomes among entrepreneurs becomes more polarized (in the sense of Esteban and Ray, 1994).[10] To summarize, the model does not give us any reason to expect a clear-cut positive impact of trade on measures of aggregate economic performance (e.g., the GDP per capita) in developing countries. However, assuming that the owners of the biggest companies belong to the top income earners, the model does predict that an opening of trade increases the share of the GDP that goes to those at the very top of the distribution, with the richest among the rich winning most also in relative terms.

These predictions match the broad patterns observed in cross-country data. As has been discussed for a while, the empirical literature on trade barriers and economic performance in developing countries does not find any robust results. There are a number of studies (Dorwick and Golley; 2004; DeJong and Ripoll, 2006) that identify a positive impact of openness on growth in more advanced economies but no effect whatsoever in developing countries. Other papers find that – in developing countries – more openness is actually harmful for growth

[10] Note that, in principle, the impact of τ on measures of overall inequality (such as the Gini index) is ambiguous. The reason is that lowering τ may push entrepreneurs in the middle closer to the poorer ones. Yet, given the strong effects at the bottom and the top, lower trade barriers are likely to increase overall inequality.

(Yanikkaya, 2003); others again suggest exactly the opposite effect (e.g., Warner, 2003).

Figure 9 here

Detailed evidence on income distributions is scarcer but the data we have suggests that more openness goes hand in hand with an increase in the fraction of the GDP that goes to the top income earners. For instance, in the aftermath of significant liberalization steps in the early 1990s, the top-1% income shares in Argentina and India surged (Atkinson et al., 2011, Figure 11; Banerjee and Piketty, 2005, Figure 4). Similarly, there is evidence of surging top-income shares in Mexico (Foellmi and Oechslin, 2010) after the country liberalized trade in the mid-1980s and in Indonesia (Leigh and van der Eng, 2007) after the country joined the WTO in 1995. Finally, as can be seen from Figure 9, the prediction that higher incomes gain disproportionally is consistent with the evidence from India (which is most detailed). The figure shows the evolution of the top 1%, top 0.5%, top 0.1%, and top 0.01% income shares during the 1990s (indexed, with 1990 as the base year), together with the evolution of tariffs. All of these income shares increased significantly as tariffs fell but – as predicted by the model – the richest among the rich won most even in relative terms: The top 0.01% share rose strongest, followed by the top 0.1%, 0.5%, and 1% shares.

Within-country evidence. A substantial part of the within-country evidence comes from India in the early 1990s, i.e., from a period during which the country liberalized trade rapidly in return for IMF assistance. Overall, this literature does not suggest that the pro-competitive effects of trade strongly improved allocative efficiency or firm productivity. Evidence on allocative efficiency in India can be found in Hsieh and Klenow (2009) who relate the actual output to the (hypothetical) efficient output, i.e., the level of output that would be achieved if the production factors were efficiently allocated across firms. This "efficiency ratio" is available for three years, and the numbers are 0.50 in 1987, 0.49 in 1991, and 0.44 in 1994 (Hsieh and Klenow, 2009, Table IV). Thus, quite surprisingly, liberalizing trade went hand in hand with a strong deterioration in allocative efficiency. Such a deterioration, however, also occurs in the two-group example discussed above. A fall in τ that forces the small firms to use the low-productivity technology (i.e., pushes the economy from constellation $(\tau P, aE)$ to $(\tau P, aR)$) leads to a fall in the "efficiency ratio", reflecting that part of the capital stock is allocated to less productive firms in the new equilibrium.[11] There are further some more subtle developments that are captured by the numerical example. On the one hand, Hsieh and Klenow (2009,

[11] In the context of your simple one-sector/one-factor economy, TFPQ and TFPR are given by z and pz, respectively, where $z \in \{a, b\}$. The equivalent of Hsieh and Klenow's (2009) measure of the efficient output,

Table I) document an increase in the dispersion of physical productivities (TFPQ) across firms in the early 1990s – which is exactly what the example suggests. On the other hand, they find (Table II) a mild decline in the dispersion of revenue productivities (TFPR). We observe a similar pattern as those firms with an initially high TFPR see their prices and TFPQ fall while firms with an initially low TFPR experience a price increase.

The evidence on the impact of trade on firm productivity in India is less surprising. Overall, however, it does not seem that the pro-competitive effects of trade lead to a substantial improvement in this dimension. For instance, focusing on big formal-sector firms, Topalova and Khandelwal (2011) do find a positive effect on average firm productivity. Yet, this effect is quite small: A 10 percentage point decline in output tariffs leads to a 0.32% improvement in productivity (which implies that the enormous decline of 54 percentage points in the first half of the 1990s lifted productivity by a modest 1.7% on average). Moreover, this positive effect seems to disappear once the sample is extended to include all formal-sector firms and not only the big companies (see Nataraj, 2011), probably suggesting that the smaller firms became less productive.[12] Note that such a pattern can be generated by a slightly extended version of the present model. This extension would include a third and even more productive technology which, however, would require an even higher investment level and hence would only be operated by the big exporters after a decline in τ.

4.2 Policy Implications

Although we show that – in places with significant financial frictions and asset inequality – globalization may have negative effects on the economy, our analysis does not suggest that poor countries should stay away from trade liberalization. Such a conclusion would be inappropriate for two different reasons. First, we find that only an incomplete opening of trade, i.e., a reform that falls short of fully integrating the country into the world economy, may have detrimental effects on aggregate variables. A reform that brings the trade cost close to zero will always be beneficial. Second, even a modest reduction in trade barriers could be helpful if it were

$Y_{efficient}$, is $\left(\beta(z_P)^{\sigma-1} + (1-\beta)(z_R)^{\sigma-1}\right)^{1/(\sigma-1)}$, and so on. The numerical example we discuss here considers a fall in τ from 1.4 to 1.25, relying on the parameter values given in Figure 5.

[12] While the evidence does not suggest a significant role of the pro-competitive channel, it clearly supports the relevance of the input channel: Both papers find that a fall in input tariffs boosts average firm productivity (as firms gain access to cheaper and more input factors). A similar pattern is documented for Indonesia, a country which liberalized trade in the second half of the 1990s (see Amiti and Konings, 2007).

implemented together with complementary reforms.[13] Since the potentially negative effect of a partial liberalization comes from tighter credit constraints, the complementary measures should concentrate on the credit market. One option would be to improve credit contract enforcement (i.e., to increase λ). If the improvement were sufficiently high, the borrowing constraints would ease even though mark-ups shrink. As a result, smaller firms would no longer have to cut production or switch to a less productive technology. Moreover, strengthening contract enforcement would ensure that the smaller firms face less steep declines in income.

Yet, a significant improvement in the quality of credit contract enforcement may be difficult to achieve. Arguably, 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 (equation 9'), introducing a subsidized-credit scheme for constrained firms would have a very similar effect. The subsidy could be financed through an income tax (i.e., a tax on m_i) which has upon introduction only welfare costs of second order (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 trade and finance literature, emphasizing fixed costs of entering foreign markets, would rather suggest that such programs should be directed towards big export-oriented companies.

5 Summary and Conclusions

We study the macroeconomic implications of trade liberalization in a monopolistically competitive economy that features technology choice and credit market frictions. Our analysis generates two main findings. First, in contrast to much of the recent literature which 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. This deterioration in the access to credit has two different, though related, effects. On the one hand, while not driven out of the market, some smaller firms are forced to switch to less productive technologies (polarization effect). On the other hand, the loss in output generated by the smaller firm must be compensated through higher im-

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

ports – which requires the economy to spend more on trade-related costs (replacement effect). The second finding relates to the income distribution. We show that integrating into world markets amplifies any pre-existing polarization in entrepreneurial incomes. This finding is an immediate corollary of the adjustments in firm sizes and technology choices: The less-affluent entrepreneurs are forced to reduce investments and to charge lower mark-ups whereas the richer entrepreneurs benefit from the access to new markets abroad. It turns out that our framework matches several salient patterns in the evidence – both within-country and cross-country – on the effects of trade in the developing economies, i.e., in places where strong credit market frictions and high wealth inequality abound. One conclusion from our analysis is that developing countries should liberalize trade as part of a broader reform agenda that also addresses credit market frictions. In particular, an opening of trade should go along with measures that avoid a tightening of credit constraints faced by smaller firms. There are numerous possible measures, some of them more modest (like the introduction of subsidized-credit schemes) and some of them more ambitious (like improving the quality of credit contract enforcement).

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APPENDIX I: PROOFS

Proof of Proposition 1. (i) We first focus 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. The second step is then to prove also 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 (13). Suppose now that x is exactly equal to the threshold given in (10). 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 (10) to infinity. Expressions (9) and (11) 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

$$P^{1-\sigma} = \int_0^{\widetilde{\omega}} [p(\overline{y}(\omega))]^{1-\sigma} \, dG(\omega) + \left[\frac{\sigma}{\sigma - 1} \frac{\rho}{a}\right]^{1-\sigma} [1 - G(\widetilde{\omega})]. \tag{16}$$

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 (note that we can choose P as the numéraire and normalize to 1).

(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:

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

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 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 (9) 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

$$\begin{aligned} \frac{\sigma - 1}{\sigma} P^{(\sigma-1)/\sigma} Y^{1/\sigma} (b\kappa)^{-1/\sigma} &\geq \frac{\rho}{b} \\ \frac{P^{(\sigma-1)/\sigma} Y^{1/\sigma}}{\rho} &\geq \frac{\sigma}{\sigma - 1} \frac{1}{b} (b\kappa)^{1/\sigma}. \end{aligned} \tag{17}$$

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 (17) must be satisfied.

APPENDIX II: ANALYSIS OF THE TWO-GROUP EXAMPLE

Only poor agents price-constrained (τP). We start with a characterization of the two trade equilibria in which only the poor entrepreneurs are price-constrained. Suppose first that all agents use the high-productivity technology. Then, the output by the poor entrepreneurs is $a\theta K/(1-\lambda\tau^2)$. As a result, without facing a competitive fringe, they would charge $P^{(\sigma-1)/\sigma}Y^{1/\sigma}\left(1-\lambda\tau^2\right)^{1/\sigma}(\theta aK)^{-1/\sigma}$. This expression must be larger than τ for the competitive fringe to be binding. To determine $P^{(\sigma-1)/\sigma}Y^{1/\sigma}$, we use the credit market equilibrium condition,

$$K = \beta\frac{1-\tau^2}{1-\lambda\tau^2}\theta K + \frac{1}{a}(1-\beta)YP^{\sigma-1}\tau^{\sigma}\left(\frac{\sigma-1}{\sigma}\right)^{\sigma} + \frac{1}{a}\beta YP^{\sigma-1}\tau^{2-\sigma},$$

which can be rearranged to obtain

$$YP^{\sigma-1} = aK\left(1-\beta\theta\frac{1-\tau^2}{1-\lambda\tau^2}\right)\left((1-\beta)\tau^{\sigma}\left(\frac{\sigma-1}{\sigma}\right)^{\sigma}+\beta\tau^{2-\sigma}\right)^{-1}. \qquad (18)$$

This result allows us to express the condition for the competitive fringe to be binding in terms of exogenous variables only. In particular, we obtain

$$\theta < \left(1-\lambda\tau^2\right)\left(\beta+(1-\beta)\left(\tau^2\frac{\sigma-1}{\sigma}\right)^{\sigma}\right)^{-1}. \qquad (19)$$

We proceed to explicitly calculate aggregate real output, Y/P, which can be interpreted as the welfare level of the average entrepreneur. To do so, we first have to determine P. Note that a share β of goods is priced at τ whereas the price of the remaining goods is $p(\widetilde{y}) = \sigma/((\sigma-1)\tau)$. As a result, we have $P^{1-\sigma} = \beta\tau^{1-\sigma} + (1-\beta)\left(\sigma/((\sigma-1)\tau)\right)^{1-\sigma}$. We use this latter expression in (18) and obtain (recall $U = Y/P$)

$$U^{aE,\tau P} = aK\left(1-\beta\theta\frac{1-\tau^2}{1-\lambda\tau^2}\right)\frac{\left(\beta\tau^{2(1-\sigma)}+(1-\beta)\left(\frac{\sigma-1}{\sigma}\right)^{\sigma-1}\right)^{\sigma/(\sigma-1)}}{\beta\tau^{2(1-\sigma)}+(1-\beta)\left(\frac{\sigma-1}{\sigma}\right)^{\sigma}}. \qquad (20)$$

Suppose now that the the poor entrepreneurs use the low-productivity technology. This happens if $\omega_{\kappa}^{I} = \left(1-\lambda\tau^2\right)\kappa > \theta K$ and $\tau^2 > a/b$. After going through a similar series of steps, we find that aggregate real output in this case is given by

$$U^{aR,\tau P} = aK\left(1-\beta\theta\frac{1-\tau^2 b/a}{1-\lambda\tau^2 b/a}\right)\frac{\left(\beta\tau^{2(1-\sigma)}+(1-\beta)\left(\frac{\sigma-1}{\sigma}\right)^{\sigma-1}\right)^{\sigma/(\sigma-1)}}{\beta\tau^{2(1-\sigma)}+(1-\beta)\left(\frac{\sigma-1}{\sigma}\right)^{\sigma}},$$

which is obviously smaller than the expression in (20). The condition for the competitive fringe to be binding is $\theta < \left(1-\lambda\tau^2 b/a\right)\left(\beta+(1-\beta)\left(\tau^2(\sigma-1)/\sigma\right)^{\sigma}\right)^{-1}$.

All agents price-constrained (τE). We now turn to the equilibria in which all entrepreneurs are price-constrained and hence set their prices equal to τ (so that $P = \tau$). This happens if $\tau < p(\widetilde{y})$ or, equivalently, $\tau < (\sigma/(\sigma-1))^{1/2}$. As in the two cases above, $YP^{\sigma-1}$ can be determined by looking at the credit market equilibrium condition. In the constellation where all entrepreneurs use the high-productivity technology, this condition reads $K = \beta(1-\tau^2)(1-\lambda\tau^2)^{-1}\theta K + a^{-1}YP^{\sigma-1}\tau^{-\sigma}(1-\beta) + a^{-1}\beta YP^{\sigma-1}\tau^{2-\sigma}$ (and there is a related condition if the poor entrepreneurs use the low-productivity technology). Real output is then given by

$$U^{aE,\tau E} = aK\left(1-\beta\theta\frac{1-\tau^2}{1-\lambda\tau^2}\right)\frac{1}{1-\beta+\beta\tau^2}$$

if all entrepreneurs operate the high-productivity technology and by

$$U^{aR,\tau E} = aK\left(1-\beta\theta\frac{1-\tau^2 b/a}{1-\lambda\tau^2 b/a}\right)\frac{1}{1-\beta+\beta\tau^2}$$

if the poor are forced to rely on the low-productivity technology. Finally, condition (19) is replaced by a condition stating that the poor agents run smaller firms than the rich ones do. If all entrepreneurs use the high-productivity technology, this holds if

$$\theta < 1-\lambda\tau^2.$$

In the case where the poor use the low-productivity technology, the condition is $\theta < 1-\lambda\tau^2 b/a$. Note that $\theta < 1-\lambda\tau^2$ implies that (19) holds (and a fortiori for the conditions relevant in the constellations where the poor use the low-productivity technology).

Group-specific real incomes. To see how individual welfare depends on trade costs, we derive the group-specific real incomes. The nominal income (revenue minus cost of borrowing) of the poor entrepreneurs, m_P, is given by $(1-\lambda)a\tau\theta K/(1-\lambda\tau^2)$ if they use the high-productivity technology; by $(1-\lambda)b\tau\theta K/(1-\lambda\tau^2 b/a)$ if they operate the low-productivity technology. Thus, the welfare level incurred by the representative poor agent, $U_P = m_P/P$, is given by

$$U_P = \begin{cases} \max\left\{\frac{(1-\lambda)b\tau}{1-\lambda\tau^2 b/a}, \frac{a}{\tau}\right\}\theta K/P & : \quad \theta K < \omega_\kappa^I = \kappa(1-\lambda\tau^2) \\ \frac{(1-\lambda)a\tau}{1-\lambda\tau^2}\theta K/P & : \quad \theta K \geq \omega_\kappa^I = \kappa(1-\lambda\tau^2) \end{cases}.$$

The nominal income of the rich entrepreneurs, m_R, reads $(p(\widetilde{y})-\rho)\,\widetilde{y} + \rho(1-\beta\theta)(1-\beta)^{-1}K$. Taking into account that $\widetilde{y} = YP^{\sigma-1}\tau^{\sigma}\left((\sigma-1)/\sigma\right)^{\sigma}$, we find that

$$U_R = \begin{cases} \left(\tau^2-1\right)YP^{\sigma-2}\tau^{\sigma-1}\left(\frac{\sigma-1}{\sigma}\right)^{\sigma} + \frac{a}{\tau}\frac{1-\beta\theta}{1-\beta}K/P & : \quad \tau^2 < \sigma/(\sigma-1) \\ \frac{1}{\sigma-1}YP^{\sigma-2}\tau^{\sigma-1}\left(\frac{\sigma-1}{\sigma}\right)^{\sigma} + \frac{a}{\tau}\frac{1-\beta\theta}{1-\beta}K/P & : \quad \tau^2 \geq \sigma/(\sigma-1) \end{cases}.$$

Figures

***Figure* 1** – Maximum firm output

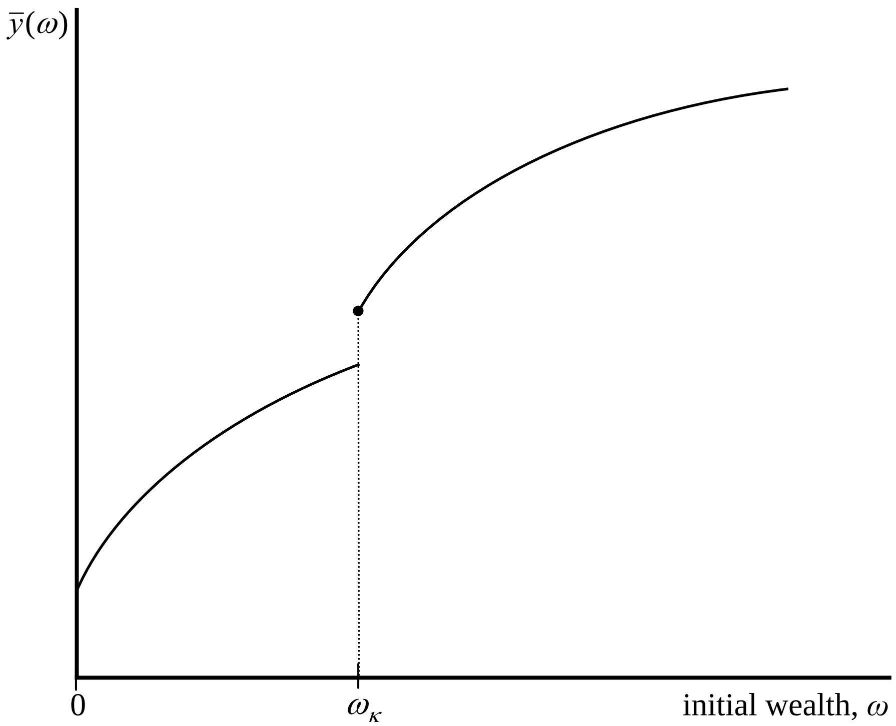
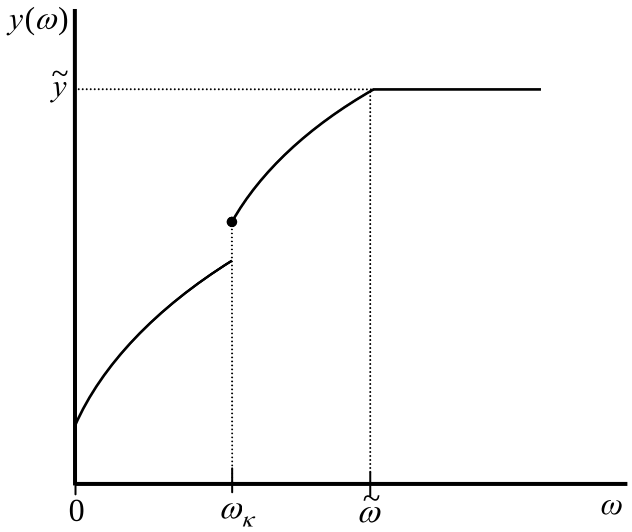


***Figure* 2** – Equilibrium firm outputs (assuming $\lambda < (\sigma - 1)/\sigma$)

a. Some firms use the less productive technology



b. All firms use the more productive technology

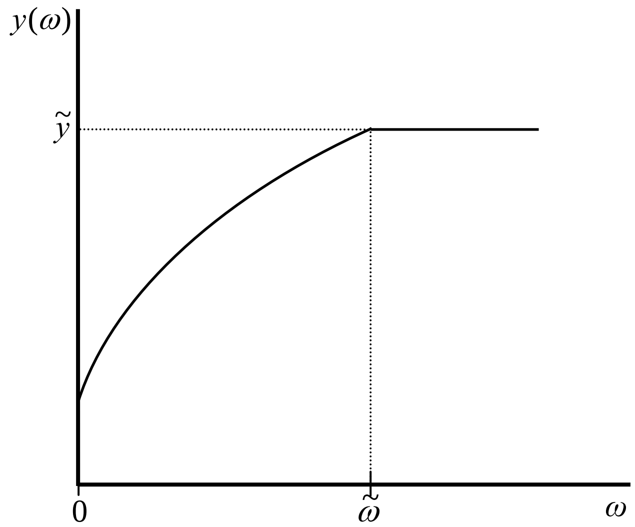


***Figure* 3** – Aggregate gross capital demand (assuming $\lambda < (\sigma - 1)/\sigma$)

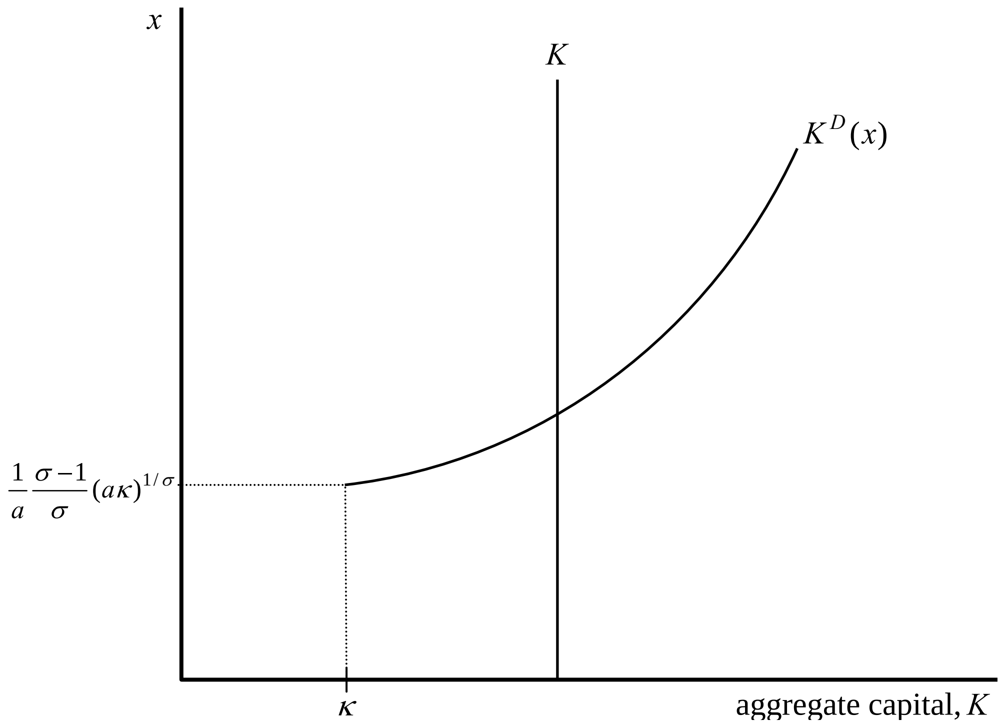


***Figure* 4** – Trade barriers and nominal incomes

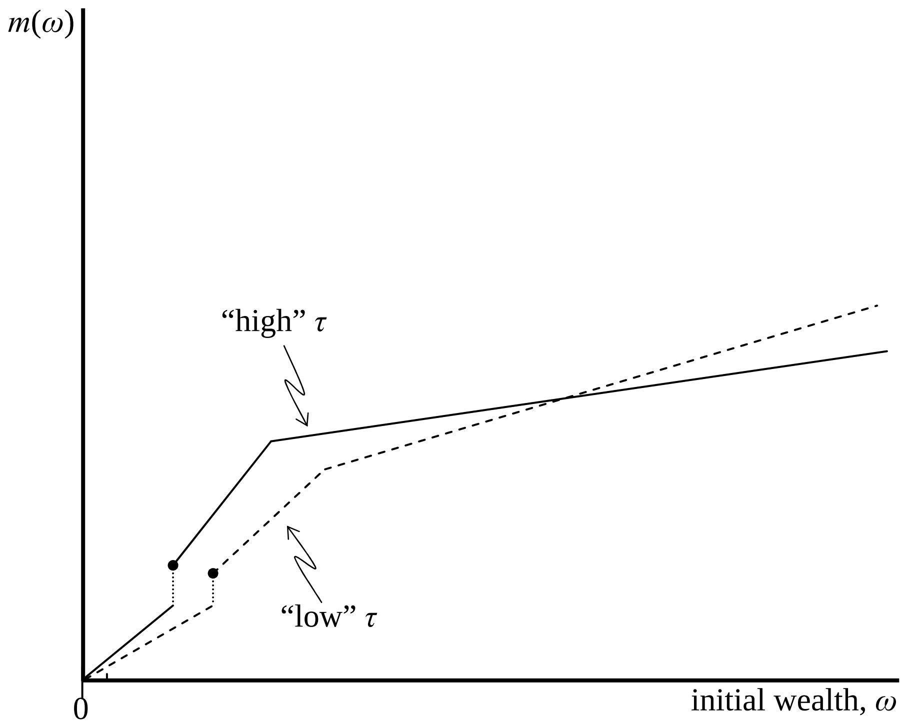
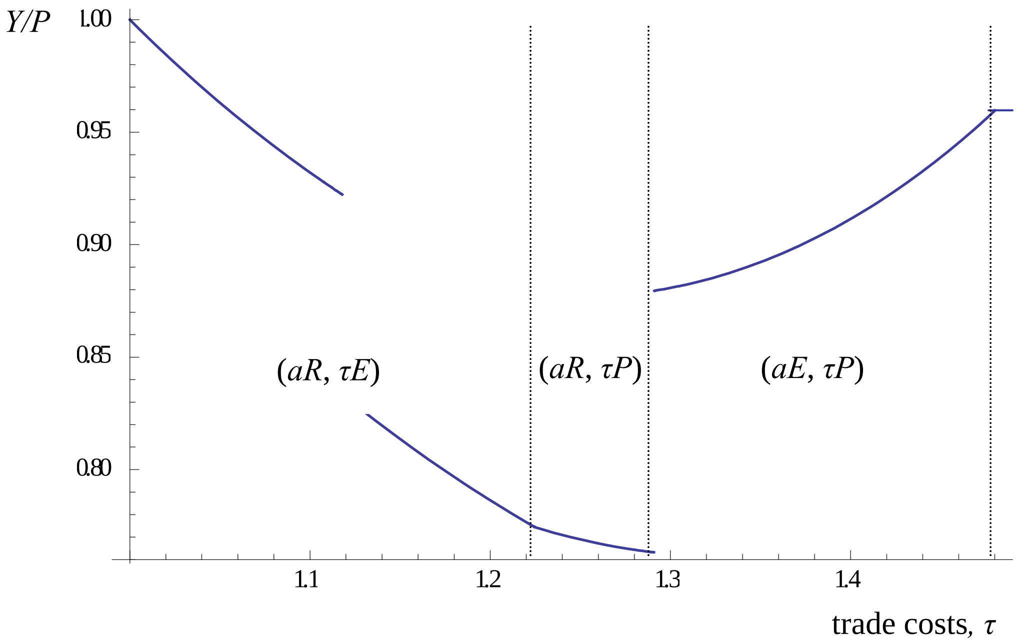
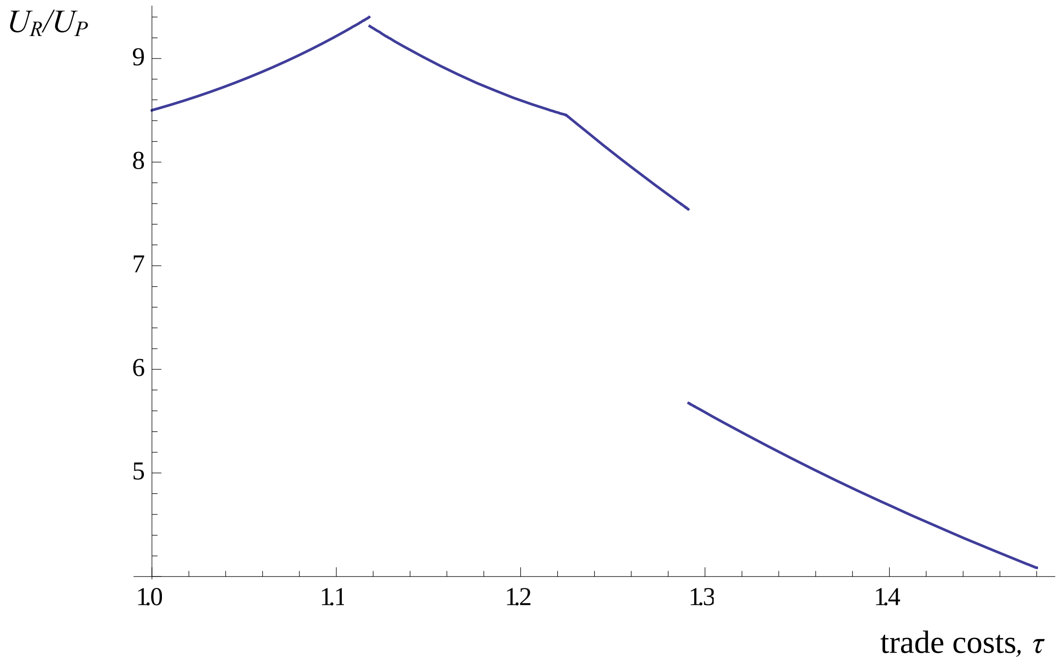


***Figure* 5** – Real output as a function of trade costs



Parameter values: $K = 1$, $a = 1$, $b = 0.8$, $\beta = 0.8$, $\kappa = 0.6$, $\lambda = 0.2$, $\sigma = 3$, $\theta = 0.4$

***Figure* 6** – Income ratio as a function of trade costs

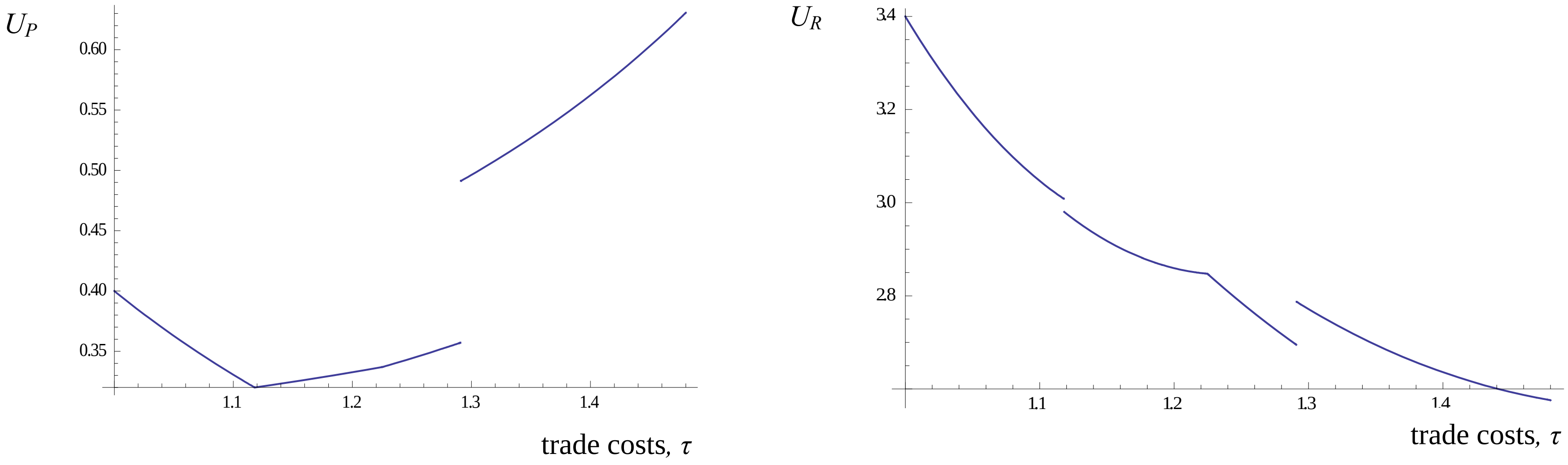


Parameter values: $K = 1$, $a = 1$, $b = 0.8$, $\beta = 0.8$, $\kappa = 0.6$, $\lambda = 0.2$, $\sigma = 3$, $\theta = 0.4$

***Figure* 7** – Real income of the rich and poor as functions of trade costs

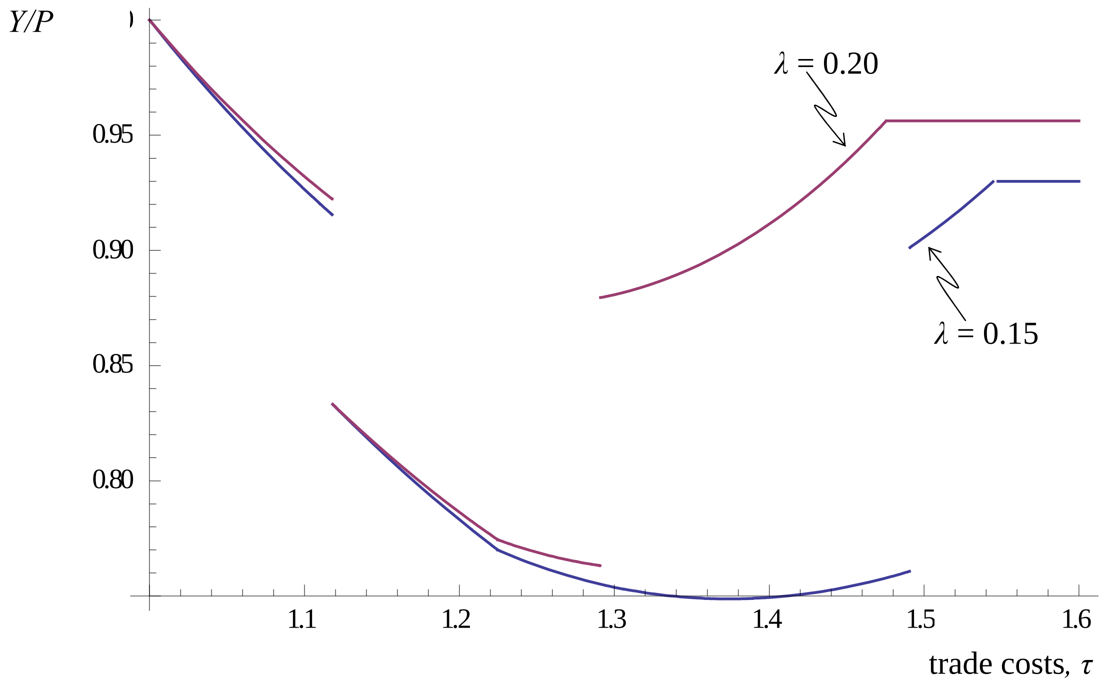
a. Real income of the poor agents

b. Real income of the rich agents



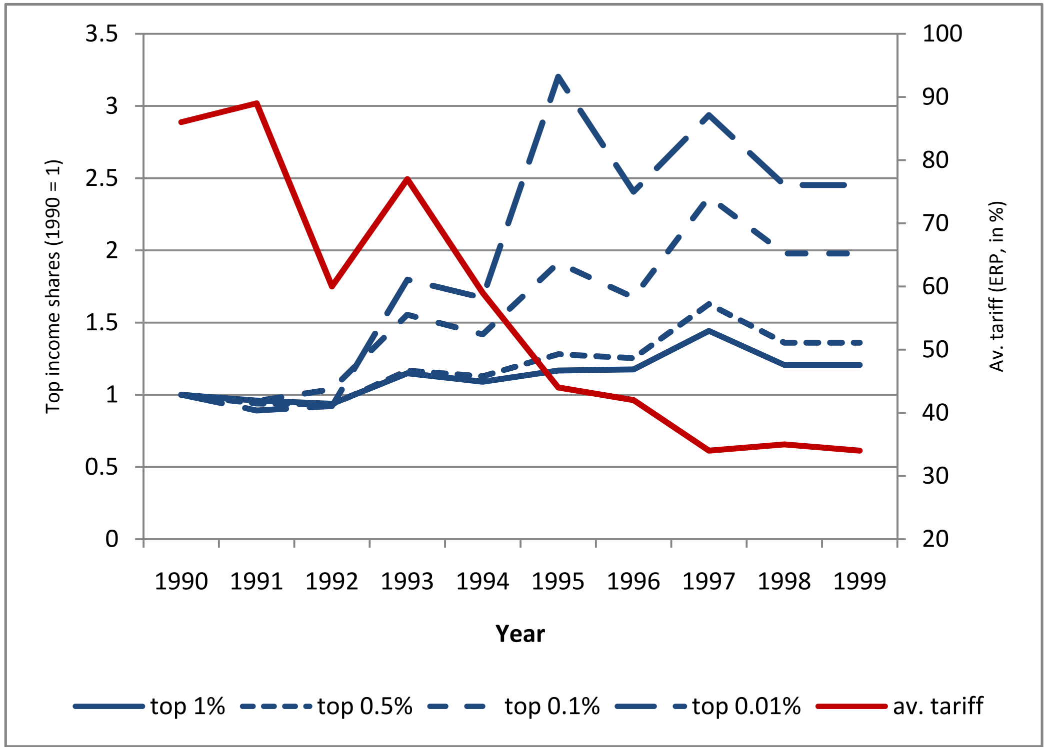
Parameter values: $K = 1$, $a = 1$, $b = 0.8$, $\beta = 0.8$, $\kappa = 0.6$, $\lambda = 0.2$, $\sigma = 3$, $\theta = 0.4$

***Figure* 8 –** Real output as a function of trade costs, with stronger (λ = 0.15) and weaker (λ = 0.20) credit market frictions



Parameter values: K = 1, a = 1, b = 0.8, β = 0.8, κ = 0.6, σ = 3, θ = 0.4

***Figure* 9** – India in the 1990s



Sources: Top income shares: World Top Incomes Database (http://g-mond.parisschoolofeconomics.eu/topincomes/).
Average tariffs: Topalova and Khandelwal (2011, Table 1); average tariff refers to average effective rate of protection.